Analysis of Conservation Priorities for the Bureau of Land Management's Superior-Cronese Desert Tortoise Management Area

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Prepared by

SWCA Environmental Consultants

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ANALYSIS OF CONSERVATION PRIORITIES FOR THE BUREAU OF LAND MANAGEMENT'S SUPERIOR-CRONESE DESERT TORTOISE MANAGEMENT AREA

Prepared for:

Bureau of Land Management
National Office
1620 L Street NW
Washington, D.C. 10036
Technical Representative: Kim Tripp

Prepared by:

SWCA Environmental Consultants
150 S Arroyo Parkway, Second Floor
Pasadena, California 91105
Principal Investigator: Michael W. Tuma

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1. INTRODUCTION

1.1 Background and Purpose

Agassiz's desert tortoise (*Gopherus agassizii*) ranges over approximately 24.5 million acres within the Mojave and Colorado Deserts in southern California, southern Nevada, northwest Arizona, and southwest Utah (Figure 1). The Bureau of Land Management (BLM) manages some 12.6 million acres of publicly-owned lands within this range; accordingly, the majority of appropriate conservation areas needed for the long-term viability of desert tortoise populations are located on federal lands managed by the BLM. Indeed, the BLM has played and will continue to play a major role in the perseverance of the species through their land management practices and implementation of conservation techniques.

Our understanding of the biology of the desert tortoise has advanced, and so too should our implementation of compatible land use prescriptions and conservation strategies for the species. Previous plans for managing habitats and conserving desert tortoise populations have predominantly considered the species on a range-wide scale, with recommendations that are rather general in nature. However, the desert tortoise faces a multitude of threats across its range, and the distribution and severity of these threats to desert tortoise populations varies considerably from place to place. What is needed is an approach to desert tortoise conservation that considers the specific types and distributions of threats at a local scale in order for local land managers to effectively manage and conserve the species.

The purpose of this document is to present BLM land managers in the California Desert District Office with a preliminary set of recommendations for prioritizing and prescribing land management and tortoise conservation techniques on BLM-managed lands within the Superior-Cronese Critical Habitat Unit. The conservation priorities recommended herein were developed from several analyses, including a preliminary analysis of the distribution and severity of threats to desert tortoise populations, a review and analysis of previously implemented conservation efforts by the BLM, and development of habitat and population models to simulate the effects of threats on desert tortoise populations on BLM-managed lands within the Superior-Cronese Critical Habitat Unit. The results of the population modeling were used to develop a ranking of the importance of the threats in causing population decline, which allowed for a prioritization of management and conservation recommendations. Population modeling is a widely used technique among conservation biologists, as it allows for the development of more informed decisions pertaining to the management of rare species (Bakker et al. 2009). Despite its wide use, population modeling has its limitations, primarily due to the difficulty of including uncertainties and stochasticity that exist in complicated natural systems, but are difficult or impossible to parameterize in models. As such, though population modeling efforts attempt to simulate reality, their results do not provide real predictions of how populations may respond to environmental perturbations. Population models are a useful way to develop hypotheses concerning natural ecological processes, and the predictive power of population models may be strengthened by testing hypotheses with field data. The population modeling effort that supports this document compared various scenarios of population response to anthropogenic threats. The modeled threats were applied individually to a stable modeled population individually in order to determine their relative effects in causing population decline. Thus, while the modeled population response would be a poor predictor of actual response in real populations, this technique was useful for ranking the importance of the threats in order to derive the preliminary management prescriptions provided herein. Subsequent field data collection could be used to test these conclusions and strengthen the model, which may provide more informed management prescriptions.

1.1.1 U.S. Fish and Wildlife Service Management History

Endangered Species Act Listing

Agassiz's desert tortoise (formerly referred to as the Mojave population of the desert tortoise) was listed under the Endangered Species Act (ESA) by the U.S. Fish and Wildlife Service (USFWS) following concerns that several populations had undergone significant and precipitous declines (USFWS 1990). It was believed that a respiratory disease initially called Upper Respiratory Disease Syndrome (URDS)—now known as Upper Respiratory Tract Disease (URTD)—had reached epidemic levels and was responsible for the declines. In response to reports from scientists and managers in the field, the USFWS emergency-listed tortoise populations located north and west of the Colorado River in California, Nevada, Utah, and the northwestern portion of Arizona) as endangered on August 4, 1989 (USFWS 1989). The USFWS subsequently down-listed this population to threatened status in a final rule issued on April 2, 1990 (USFWS 1990).

Critical Habitat Designation

The USFWS published the final rule for designation of 6,446,200 acres of Critical Habitat for desert tortoise on February 8, 1994 (USFWS 1994a). The boundaries of the designated Critical Habitat units generally corresponded to the boundaries of the Desert Wildlife Management Areas (DWMA) that were recommended by the USFWS-appointed desert tortoise recovery team and presented in the 1994 Recovery Plan (USFWS 1994b) (Figure 1). Sixty-three percent (4,071,787 acres) of designated desert tortoise Critical Habitat occurs on federal lands managed by the BLM.

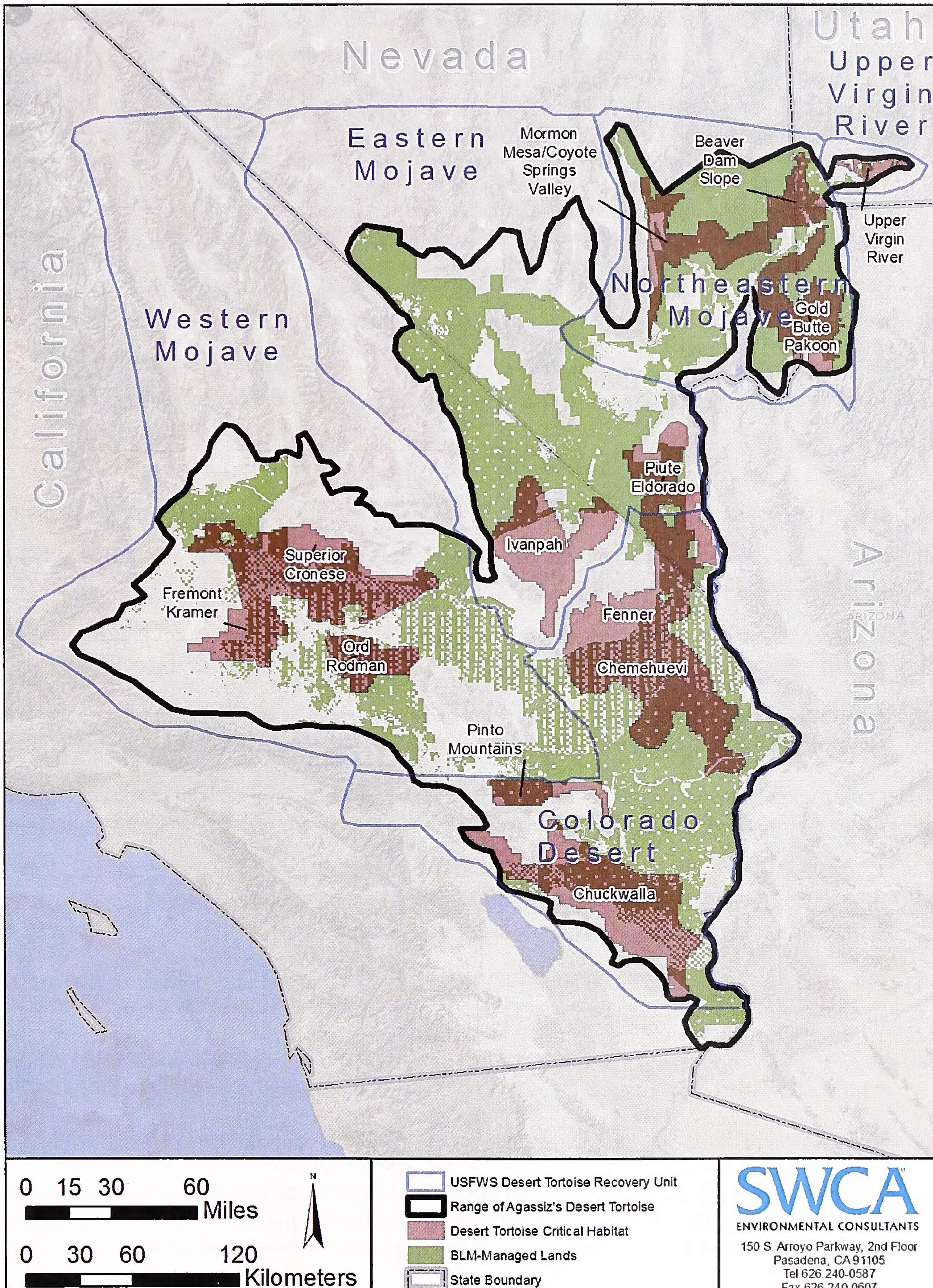

Figure 1. BLM Lands, Recovery Units, and Critical Habitat Units within the range of Agassiz's desert tortoise.

Recovery Plan

1994 Desert Tortoise (Mojave Population) Recovery Plan

In June 1994, the USFWS published the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994b). This Recovery Plan outlined criteria for delisting of the Mojave population of the desert tortoise (*c.f.*, Agassiz's desert tortoise [Murphy et al. 2011]), which included: (1) a statistically significant upward trend or stability of population sizes for at least 25 years, as determined through a monitoring program, (2) protection of desert tortoise populations and habitat within a recovery unit (or intensive management of populations and habitat without recovery unit designation), (3) management within recovery unit(s) must result in population growth rates (λ) at or above 1.0, (4) implementing regulations or land management strategies that provide long-term protection of desert tortoises and their habitat, and (5) continued protection of the population under the Endangered Species Act. Recovery actions recommended in the Recovery Plan included:

- Establish DWMAs and implement management plans for each of the six recovery units.
- Establish environmental education programs.
- Initiate research necessary to monitor and guide recovery efforts.

Additionally, specific recovery actions were identified for each of the DWMAs. The following Specific Management Actions were recommended for the Superior-Cronese DWMA:

- Remove livestock grazing or, if desired, establish terms for experimental cattle grazing in experimental management zones (EMZs).
- Establish a drop-off site for unwanted captive desert tortoises at BLM's Barstow Way Station. Develop programs to make unwanted captives available for research and educational purposes.
- Construct barrier fencing along Interstate 15, Ft. Irwin Road, Manix Trail, Superior Lake Road, and the northern border of the DWMA to protect desert tortoises from vehicles, collection, and habitat degradation.
- Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.
- Construct highway underpasses along Ft. Irwin Road to allow desert tortoise movement and to facilitate genetic exchange throughout this DWMA.
- Reduce raven populations in the DWMA to lessen mortality of small desert tortoises to a point at which recruitment into the adult cohort can occur at as rapid a rate as possible.
- Initiate cleanup of surface toxic chemicals and unexploded ordnance.
- Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts. Along the boundary with the Fremont-Kramer DWMA, a double row of desert tortoise barrier fencing may be necessary to prevent the spread of URTD into the Superior-Cronese DWMA.

2011 Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*)

In August 2011, the USFWS published the Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*) (USFWS 2011) to address deficiencies in the 1994 Recovery Plan. The USFWS recognized that the most significant challenge to implementing the 1994 Recovery Plan was a lack of details regarding how recovery actions should be coordinated among agencies, and how they should be documented, described, and evaluated for success. The 2011 Revised Recovery Plan included the following strategic elements to guide recovery actions:

1. Develop, support, and build partnerships to facilitate recovery.
2. Protect existing populations and habitat, instituting habitat restoration where necessary.
3. Augment depleted populations in a strategic manner.
4. Monitor progress toward recovery.
5. Conduct applied research and modeling in support of recovery efforts within a strategic framework.
6. Implement a formal adaptive management program.

Additionally, the recovery criteria were revised slightly to include the following:

Recovery Objective 1 (Demography): Maintain self-sustaining populations of desert tortoises within each recovery unit into the future.

Recovery Criterion 1: Rates of population change (λ) for desert tortoises are increasing (i.e., $\lambda > 1$) over at least 25 years (a single tortoise generation), as measured:

a) by extensive, range-wide monitoring across tortoise conservation areas within each recovery unit, and

b) by direct monitoring and estimation of vital rates (recruitment, survival) from demographic study areas within each recovery unit.

Recovery Objective 2 (Distribution): Maintain well-distributed populations of desert tortoises throughout each recovery unit.

Recovery Criterion 2: Distribution of desert tortoises throughout each tortoise conservation area is increasing over at least 25 years (i.e., ψ [occupancy] > 0).

Recovery Objective 3 (Habitat): Ensure that habitat within each recovery unit is protected and managed to support long-term viability of desert tortoise populations.

Recovery Criterion 3: The quantity of desert tortoise habitat within each desert tortoise conservation area is maintained with no net loss until tortoise population viability is ensured. When parameters relating habitat quality to tortoise populations are defined and a mechanism to track these parameters established, the condition of desert tortoise habitat should also be demonstrably improving.

1.1.2 Role of the BLM in Desert Tortoise Conservation

The BLM is responsible for listed species management on BLM-managed federal lands, and BLM land managers have a long history of implementing land management techniques and conservation/recovery actions for the desert tortoise. The BLM's management of this species dates back to the mid-1970s, when the Desert Tortoise Natural Area was established on BLM-managed lands in Kern County, California. The BLM afforded protection to additional areas supporting important desert tortoise habitat and large tortoise populations with the establishment of Areas of Critical Environmental Concern (ACEC). In 1980, the first desert tortoise areas to be protected with this designation were the Beaver Dam Slope in Utah, where the Woodbury Desert Study Area is located, and Chuckwalla Bench in California, a site that supports perhaps the highest tortoise population densities within the species' range. Since then the BLM has established more than 4 million acres of ACEC throughout the Mojave and Colorado Deserts as a measure to afford greater protection to desert tortoise populations. The BLM has also been a key participant in the development of several Habitat Conservation Plans (HCP) that protect desert tortoise populations. These HCPs, which were developed through Section 10(a) of the ESA, include the Washington County HCP in Utah, the Clark County Short-term Desert Tortoise HCP in Nevada, and its replacement – the Clark County Multiple Species HCP. Under the Clark County Multiple Species HCP, the BLM has funded numerous desert tortoise conservation projects, including the Desert Tortoise Conservation Center outside of Las Vegas. Many other conservation projects implemented by the BLM in Nevada have been funded by the Southern Nevada Public Land Management Act (SNPLMA). In California, the BLM is working to develop the West Mojave Plan, an amendment to the California Desert Conservation Area Plan (1980, amended 1999) (BLM 1999), which would afford protection to desert tortoise populations throughout the Mojave and Colorado Deserts in California. The BLM also participates as a partner in the Desert Tortoise Management Oversight Group and the Desert Managers Group, which are ensembles of federal land managers that coordinate, plan, and implement measures designed to promote conservation and healthy desert ecosystems.

Despite the long history of the BLM in planning and implementing efforts to recover desert tortoise, the long-term viability of tortoise populations on BLM-managed lands remains questionable in the face of both historical and novel threats. This may be due in part to the complicated nature of the numerous threats to desert tortoise populations, including the manner in which many threats combine to produce cumulative effects, as well as the manner in which threats vary in occurrence and severity across space and time. Therefore, management strategies may be improved if they are based on area-specific conservation plans.

1.1.3 Need for Area-specific Desert Tortoise Conservation Planning

The decline in desert tortoise population densities and abundances since the 1970s has been attributed to numerous threats, and the plight of the desert tortoise has been described as a "death by a thousand cuts." In the final rule for Endangered Species Act listing, the USFWS attributed population decline to two major factors: 1) habitat loss and degradation caused by human activities such as off-highway vehicle (OHV) use, urbanization, agriculture, energy development, military training, mining, and livestock grazing; and 2) mortality of individual desert tortoises to disease (URTD), increased predation by common ravens (*Corvus corax*), collection by humans for pets or consumption, and collisions with vehicles on paved and unpaved roads (USFWS 1990). They concluded in the 1994 Recovery Plan that these threats cumulatively contributed to desert tortoise population declines across the Mojave Desert region (USFWS 1994b).

Discussions pertaining to threats to desert tortoise populations and habitat have been previously published, including threats reviews in the USFWS recovery plans (USFWS 1994b; USFWS 2011, Appendix A) and reviews by the USGS (Boarman 2002a) and the Desert Tortoise Recovery Plan

Assessment Committee (Tracy et al. 2004). These reviews, while fairly exhaustive of the types of threats that contribute to desert tortoise population decline, discuss the threats in a general manner, and within the context of the range-wide distribution of the species (with the exception of Boarman [2002a], which discussed threats in the western Mojave Desert). These reviews did not discuss how threats may vary in severity or distribution across the species' range, nor do they prioritize the importance of the threats in affecting desert tortoise populations. Accordingly, because the threats were reviewed in this generalized, range-wide manner, any land management and/or species conservation measures developed from them are likely to be generalized as well. For example, the Specific Management Actions provided within the 1994 Recovery Plan (USFWS 1994b) did not contain a prioritization of management strategies based on the severity of threats or their effects, as the data that would support this approach were generally unknown when the plan was developed (GAO 2002). Since little was known about the effects of threats on desert tortoise populations when the recommendations were developed, some of the Specific Management Actions may be uninformed and possibly misguided.

As well, there has been no analysis of the effects of the implementation of any management prescriptions that stemmed from these threats analyses. For example, the BLM has implemented a number of the Specific Management Actions recommended in the 1994 Recovery Plan (USFWS 1994b), but no research has been conducted to determine whether implementing these actions resulted in a benefit for desert tortoises or their habitat. It is poorly understood whether restricting OHV use, livestock grazing, or other activities in desert tortoise habitat has resulted in an improvement in desert tortoise habitat or a leveling or reversing of population declines. Likewise, the effects of implementing other management actions, such as fencing roads, closing mines, increasing law enforcement, and restoring habitat, are similarly unknown. For these reasons, the Government Accountability Office (GAO 2002) recommended that the USFWS and land management agencies develop and implement a coordinated research strategy to develop land management decisions with research results. The Revised Recovery Plan (USFWS 2011) has likewise recommended a strategy of 'adaptive management' of threats to desert tortoise populations as new research concerning their effects becomes available.

What is needed, since threats to tortoise populations vary in occurrence, distribution, and severity across the range of the species, is an understanding of population response to threats at a local scale. With knowledge of the types of threats, their distributions within management areas, and the manner in which they combine to produce cumulative effects would allow for the identification and prioritization of management techniques that should be implemented to enhance population recovery. The goal of this conservation plan, therefore, is to overcome deficiencies in previous threats analyses and management recommendations by examining and prioritizing threats specific to the Superior-Cronese desert tortoise management area and developing conservation and management priorities for tortoise populations residing there.

1.2 Conservation Analysis Outline

1.2.1 Report Organization

This document was developed specifically for the Superior-Cronese desert tortoise management area (management area), and includes in the following:

Description of the Desert Tortoise: This section provides a comprehensive and up-to-date review of desert tortoise biology. The purpose of this section is to provide a context for the review of threats to desert tortoise populations and recommendations for managing them. For example, one management recommendation pertains to restoring desert tortoise habitat in areas that have been disturbed by human activities. The review of habitat requirements within the *Description of the Desert Tortoise* section

provides information that could assist BLM managers in the selection of seeds and plants used in restoration efforts. As well, the review of desert tortoise biology in this section will help inform and educate any new BLM managers who have little or no experience with desert tortoise management. The synthesis in this section may also assist BLM managers in educating and informing the public with respect to management policies that affect land uses.

Description of the Management Area: This section provides a brief description of the Superior-Cronese desert tortoise management area. Included are maps detailing the various land designations within the management area, and a detailed description of threats to desert tortoise populations there.

Previous Desert Tortoise Management Plans and Their Implementation: This section provides a review of various BLM land use and resource management plans that include management recommendations and decisions pertaining to management of desert tortoise habitat and conservation of desert tortoise populations. This review includes an assessment of how these plans have been implemented within the management area since they were approved. Finally, this section provides a review of the BLM's implementation of general measures and Specific Management Actions that were recommended by the USFWS in the 1994 Desert Tortoise Recovery Plan.

Recommended Future Management Priorities: This section draws upon the results of the analyses performed in support of this document in prioritizing the importance of threats to desert tortoise populations within the Superior-Cronese management area, and discusses specific recommendations that pertain to mitigating or eliminating these threats. The recommendations provided in this section are paired with Recovery Actions provided by the USFWS in the 2011 Revised Desert Tortoise Recovery Plan.

1.2.2 Methods Used to Develop This Document

This conservation analysis is based upon the results of modeling efforts, including the development of habitat and population models. The methods and results of these efforts are contained in the attached appendices:

- Appendix A: Preliminary Analyses of Threats and Population Trends
- Appendix B: Development of the Habitat Model
- Appendix C: Development of the Population Model

2. DESCRIPTION OF THE DESERT TORTOISE

2.1 Physical Description

The desert tortoise is a long-lived, medium-sized, burrowing, terrestrial turtle in the family Testudinidae. The shell is oblong, high-domed, and moderately flat dorsally. The carapace is light to very dark grayish-brown with yellow blotches in the centers of the scutes; the plastron is yellow. Neonate and juvenile desert tortoises are predominantly yellow in coloration, adding darker colored laminae at the edges of the scutes as they grow. Older specimens with worn laminae feature grayish-brown carapaces that lack the central yellow blotches characteristic of younger individuals (Photographs 1-5). Neonate tortoises are on average about 48 mm in length when they hatch, and adult tortoises may attain sizes of 260-300 mm (females) to 320-360 mm (males). Like other tortoises, the desert tortoise has a beak specialized for cutting grasses and forbs, scaly, yellowish skin, and thick, elephantine hind legs. Where they differ most from other tortoises is in their specializations for digging: they have flattened, heavily-scaled forelimbs

with well-developed muscles and thick, flattened, spade-shaped toenails. Additionally, the eye of the desert tortoise features a bright greenish-yellow or yellow iris edged or mottled with brown coloration. An anterior projection of the gular scutes on the plastron, the gular horn, is pronounced in adult males. Adult males also have shorter rear claws, longer, thicker tails, a concave plastron, and pronounced subdentary (chin) glands (Ernst and Lovich 2009).

Photograph 1. Adult male Agassiz's desert tortoise from the central Mojave Desert.

Photograph 2. Adult female Agassiz's desert tortoise from the eastern Mojave Desert.

Photograph 3. Subadult Agassiz's desert tortoise from the central Mojave Desert.

Photograph 4. Juvenile Agassiz's desert tortoise from the central Mojave Desert.

Photograph 5. Neonate Agassiz's desert tortoise from the eastern Mojave Desert.

2.2 Evolutionary Origin

Agassiz's desert tortoise (*Gopherus agassizii*) is one of several North American gopher tortoises, a group named for their burrowing and burrow-occupying behaviors. Gopher tortoises are an ancient lineage with a 34-million year history, originating on the grasslands that characterized much of the North American continent during the early Oligocene (Morafka and Berry 2002). One of the shared characters of the gopher tortoises is their fossorial behavior, which had evolved by the late Eocene in the fossil tortoise *Gopherus laticuneus* (Morafka and Berry 2002; Reynoso and Montellano-Ballesteros 2004). Speciation and geographical distribution of the gopher tortoises reached their maximum during the Miocene (Morafka and McCoy 1988), when as many as eight species of *Gopherus* ranged from the west coast of California to the east coast of Florida, and from central Mexico in the south to present day Nebraska in the north (Reynoso and Montellano-Ballesteros 2004).

Climate change and glacial events during the Pleistocene contributed to range contractions and local extinctions, fragmentation of populations, and dispersal limitations for the gopher tortoises. The current distribution of gopher tortoise species is a direct response to these Pleistocene biogeographic events (Morafka and McCoy 1988). Modern gopher tortoises fall into two clades (*polyphemus* and *agassizii*), which consist of Agassiz's desert tortoise (*G. agassizii*), Morafka's desert tortoise (*G. morafkai*), and the Texas tortoise (*G. berlandieri*) in one clade, and the gopher tortoise (*G. polyphemus*) and bolsón tortoise (*G. flavomarginatus*) in the other. The species within each of these clades differ in several morphological and behavioral features. The *polyphemus* group is characterized by morphological features in the neck and limbs that include specializations for burrowing; female-biased sexual size dimorphism; and populations clustered in 'colonies.' The *agassizii* group is characterized by more generalized neck and limb features that are indicative of their relatively more mobile, above-ground lifestyles; male-biased sexual size dimorphism; and populations dispersed more evenly over the landscape.

2.3 Life History Traits

Like the other gopher tortoises, life history characteristics of Agassiz's desert tortoise include slow growth, delayed sexual maturity, and long lives; low fecundity, iteroparous reproduction over an extended time period, and no reproductive senescence; and low survivorship of eggs, neonates, and juveniles, but

high survivorship of adults. Life history parameters are the basic structure upon which population modeling efforts and conservation planning rely; thus reliable information about the life history traits of the desert tortoise is essential in making informed management decisions for this species. Life history traits of Agassiz's desert tortoises are discussed in detail below.

2.3.1 Growth and Maturation

Desert tortoises are generally a slow-growing species, as allocation of energy toward growth is predominantly accomplished only during spring months when annual forage is available. Medica et al. (1975) determined that tortoises in Rock Valley, located in Nye County, Nevada grew during the period between mid-April and early July, that growth was greatest following years of high winter precipitation (>100 mm), and that many tortoises did not grow at all during drought years. The rate of tortoise growth is tied to the availability of spring forage, which is in turn dependent on sufficient winter rain accumulations for annual plant germination and growth. Desert tortoise growth is generally slow, and often inconsistent and variable due to fluctuating environmental conditions and forage availability.

As with other turtle species, the growth of desert tortoises is asymptotic, with younger, immature individuals growing at a higher rate until maturity is attained, as which time growth slows considerably. Medica et al. (1975) recorded an average growth rate of 9.1 mm per year at Rock Valley, and noted that juvenile and subadult tortoises attained the highest rates of growth during the study period. Miller (1932; 1955) and Patterson and Brattstrom (1972) recorded growth in group of captive desert tortoises, and reported rapid growth for the first eight years, followed by slowed growth rates in years 9-30. Age classes that exhibited the most growth were those less than 150 mm carapace length, whereas growth was slowest in tortoises greater than 225 mm carapace length (Patterson and Brattstrom 1972). Turner et al. (1987a) examined growth and maturity of juvenile desert tortoises in Rock Valley, Nevada by tracking the growth of 15 recaptured wild individuals over a 24-year period (1963-1987). They reported a period of rapid growth between ages 5 and 8 years, when shell growth averaged 12 mm per year (measured by plastron length); however, considerable and steady growth was maintained by most individuals during most years over the 24-year period. Between ages 15 and 25, growth slowed to approximately 3 to 8 mm per year.

The slow rate at which desert tortoises develop has allowed researchers to describe and define age and size classes of immature tortoises. Neonate tortoises (Morafka 1994) are newly hatched individuals that generally measure around 48 mm. They are lecithotrophic for the first six months of their life, feeding off of the reserves within a remnant yolk sac (Lance and Morafka 2001). One-year-olds (Morafka 1994; similar to Class I juveniles; Berry 1981) are those tortoises between one and two years old, with carapace lengths that vary from 48.0-60.0 mm. Juvenile tortoises (similar to Class II juveniles; Berry 1981) are minimally two years old and attain a maximum length of 110 mm approximately eight years later, when their shells attain hardness (Nagy et al. 2011). Immature tortoises (similar to immatures as defined by Berry 1981) are those tortoises between 111 and 160 mm carapace length. Subadult tortoises (similar to subadults as defined by Berry 1981) are those that exceed 161 mm in length but are not yet mature.

Turner et al. (1987a) estimated that sexual maturity was attained between 17 and 20 years of age. At Yucca Mountain, Nevada, Mueller et al. (1998) determined that the smallest female to reproduce was 209 mm carapace length, a size they estimated was achieved in 19-20 years. Female tortoises at Goffs, California typically matured at approximately 185 mm carapace length, a size attained between 11 and 20 years, depending on rate of growth (Turner et al. 1987b).

Beyond maturity, growth in desert tortoises likely slows significantly, though tortoises continue to grow until late in their lives. Berry and Woodman (1984) analyzed changes in the carapace of aging desert tortoises to determine whether characteristics such as shell size, wear, and scute laminae and bone thinning could be used as a technique for estimating the age of tortoises. They determined that body size

Table 1. Reproduction rates for female desert tortoises at several Mojave Desert study sites.

Population	Study vicinity	Proportion of sample that did not reproduce	Mean clutch frequency	Size of first clutch	Size of second clutch	Size of third clutch	Mean number of eggs per female per year ± SD
Goffs – 1983 (Turner et al. 1986)	Eastern Mojave	0	1.89	4.1	4.25	2	Not reported
Goffs – 1984 (Turner et al. 1986)	Eastern Mojave	4%	1.57	4.29	4.27	0	Not reported
Goffs – 1985 (Turner et al. 1986)	Eastern Mojave	0	1.75	4.8	5.57	6	Not reported
Ward Valley – 1991 (Karl 1998)	Southeastern Mojave	13%	2	4.19	4.27	3	8.38±0.54
Ward Valley – 1992 (Karl 1998)	Southeastern Mojave	8%	1.84	3.19	3.52	1.5	6.68±0.57
Ward Valley – 1993 (Karl 1998)	Southeastern Mojave	10%	1.82	4.19	3.25	0	6.82±.042
Ward Valley – 1994 (Karl 1998)	Southeastern Mojave	28%	1.26	3.67	4.38	0	4.87±0.63
Ward Valley – 1995 (Karl 1998)	Southeastern Mojave	7%	1.68	4.08	3.77	3	6.76±0.47
Yucca Mountain – 1993-1995 (Mueller et al. 1998)	Northern Mojave	4%	1.5	5.1	4.8	0	7.9±0.8 (1993) 7.7±0.7 (1994) 6.7±0.7 (1995)
DTNA – 1992 (Wallis et al. 1999)	Western Mojave	0	1.67	4.4	4	0	7.1±2.7
DTNA – 1993 (Wallis et al. 1999)	Western Mojave	28%	1.76	3.9	4	0	7.0±2.5
Goffs – 1992 (Wallis et al. 1999)	Eastern Mojave	25%	1.7	4.2	4.1	0	7.1±2.8
Goffs – 1993 (Wallis et al. 1999)	Eastern Mojave	9%	1.67	4.2	4.7	0	7.3±3.1

Female desert tortoises typically deposit their first clutch in late April or early May, and their second clutch in late May or June (Wallis et al. 1999). Females that deposit a third clutch do so in early to mid-July (Karl 1998; Rostal et al. 1994; Turner et al. 1986; Wallis et al. 1999). Nest sites are typically associated with tortoise burrows, most often just inside the burrow entrance, up to a distance of 60 cm inside the burrow (Turner et al. 1986). Occasionally clutches are deposited in areas not associated with a burrow, such as beneath a shrub. Female tortoises excavate nests in a fashion typical for the Testudinidae; excavation of an initial shallow depression with the forelimbs; positioning of the rear of the carapace over the depression; excavation and shaping of the nest cavity by alternately scooping sediment from the cavity with each rear foot; and careful placement of the sediments on each side of the excavated cavity. The nest cavity is flask-shaped upon completion, into which the female deposits her eggs. Following oviposition, the female covers the nest with the excavated soils using her rear feet in the same alternating fashion. Desert tortoise eggs are elliptical to nearly spherical in shape. Egg dimensions vary regionally; eggs produced by females at Goffs in the eastern Mojave Desert measured a mean length of 40.9 and a mean width of 34.0-34.6 mm, whereas eggs produced by females at the DTNA in the western Mojave Desert measured a mean length of 45.2-45.5 mm and a mean width of 37.2-37.7 mm (Wallis et al. 1999). The shells of the eggs are hard, rough in texture, and impermeable to moisture. The incubation period

lasts between 90 and 120 days, and hatchlings emerge from nests between August and mid-October. Higher temperatures result in shorter incubation periods (Lewis-Winokur and Winokur 1995). Incubation temperature also affects sex determination, as male hatchlings are produced at incubation temperatures between 26.0 and 30.6° C, and female hatchlings are produced at temperatures between 32.8 and 35.3° C (Spotila et al. 1994). The pivotal temperature, at which mixed ratios of sexes are produced, is 31.3° C (Rostal et al. 2002). Experimental nest manipulation in semi-natural conditions indicated that early season nests (deposited between May 22 and June 2) produced 100% females, and late season nests (deposited between June 17 and July 16) produced 100% males (Baxter et al. 2008). The temperature at which eggs develop also influences hatching success. Eggs hatched in laboratory conditions exhibited the greatest success (between 90 and 100%) when incubated between 28.1 and 34.0° C (Rostal et al. 2002), and when incubated in dry medium (Spotila et al. 1994). Some researchers have reported that a small proportion of oviposited eggs within wild nests are not viable and do not hatch, but the cause of the failures were unknown (Karl 1998; Bjurlin and Bissonette 2004).

2.3.4 Survivorship

Like most chelonian species, survival of desert tortoises follows a pattern characterized by low survivorship of nests and young and relatively high survivorship of adults (Wilbur and Morin 1988; Congdon et al. 1993). This type of survivorship trend, called Type III, is typical of short-lived species that produce many offspring – the majority of which do not survive. Turtles have much lower fecundity rates than do these short-lived organisms, but overcome high mortality rates of their offspring with extended reproductive lives. Thus, the pattern of survivorship in turtles has co-evolved with longevity and iteroparity.

Nests of desert tortoises are particularly susceptible to predation, as nest defense is rare and there is no parental care. Bjurlin and Bissonette (2004) reported nest predation rates of 53.3% and 16.1% in two years, with an average of 33.3% for both years. Karl (1998) similarly reported a nest predation rate of 29% over a three-year period at her Ward Valley research site.

Neonate tortoises face difficult transitions as they hatch from eggs, excavate, emerge, and disperse from subterranean nest cavities, and quickly find and secure their first cover site. Despite carrying rich energy reserves in yolk sacs, neonates experience understandably high mortality rates during this life stage. A small portion of neonates succumb when they become trapped and entombed within nest cavities. Bjurlin and Bissonette (2004) reported that 10% of neonates that hatched became entombed in the nest cavities. Karl (1998) reported that 13% of neonates became entombed within nests over a three-year period at the Ward Valley site. Neonates that successfully emerge from nests experience elevated mortality rates as they disperse from nests, and search for cover sites, and establish a cover site that will be used during their first hibernation. Predation is likely the greatest threats during this period. Bjurlin and Bissonette (2004) examined neonate survival during this period and determined success rates of 84% and 91% in 1991 and 1992. Combining nest survival, they estimated that 40% of individuals would survive from oviposition to first hibernation (Bjurlin and Bissonette 2004).

Few data exist for juvenile survivorship rates. However, juvenile tortoises likely experience continued susceptibility to predation, as they are small and exhibit soft, pliable shells for several years (Morafka 1994; Nagy et al. 2011). Recently, attention has been called to the impact of ravens on the predation of juvenile tortoises (Boarman 1993; 2003; Kristan and Boarman 2003). Though neonate and juvenile desert tortoise carcasses are routinely observed within and around raven nests and perches, the degree of importance of this predator in affecting survival rates remains unknown. The effects of other predators on juvenile tortoise survival are likewise unknown. Starvation and dehydration are likely important sources of mortality suffered by juvenile tortoises, though the effects of these stressors on survival rates in this age category are unknown. Desiccation may be particularly problematic for juvenile desert tortoises, as

Table 1. Reproduction rates for female desert tortoises at several Mojave Desert study sites.

Population	Study vicinity	Proportion of sample that did not reproduce	Mean clutch frequency	Size of first clutch	Size of second clutch	Size of third clutch	Mean number of eggs per female per year ± SD
Goffs – 1983 (Turner et al. 1986)	Eastern Mojave	0	1.89	4.1	4.25	2	Not reported
Goffs – 1984 (Turner et al. 1986)	Eastern Mojave	4%	1.57	4.29	4.27	0	Not reported
Goffs – 1985 (Turner et al. 1986)	Eastern Mojave	0	1.75	4.8	5.57	6	Not reported
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2.5 Habitat

2.5.1 Elevation Limits and Landforms

Agassi's desert tortoise occupies a broad range of landforms throughout the Mojave and Colorado Deserts, at elevations ranging from below sea level to 2,225 meters (7,300 feet) above mean sea level (msl) (Luckenbach 1982). Within California, the most favorable habitat occurs at elevations of approximately 305 to 914 meters (1,000–3,000 feet) above msl (Luckenbach 1982), though more recent evidence from range-wide monitoring efforts indicates the desert tortoises are consistently documented above 914 meters (3,000 feet) (USFWS 2006a, 2011). Survey protocol recently developed by the USFWS includes a requirement for consideration of elevations between 300 to 1,525 meters (984 to 5,000 feet) above msl. Luckenbach (1982) reported that desert tortoises are often found on valley bottoms and on bajadas. Bury et al. (1994) determined that desert tortoise populations in the eastern Mojave Desert occurred on a variety of landforms from flats and bajadas to rocky slopes. Anderson et al. (2000) modeled desert tortoise habitat using regression-tree analysis, and found that tortoises occurred in higher densities on southwest-facing slopes within their study area in the central Mojave Desert. Jennings (1997a) observed that tortoises preferred washlets, washes, and hills in most instances (92%) over desert flats (8%) at the Desert Tortoise Natural Area in the western Mojave Desert.

2.5.2 Precipitation

Outside of elevation constraints, the most important limiting factor in the distribution of desert tortoises is water availability in the form of precipitation. Not all portions of the Mojave Desert within the range of the species are occupied by individuals or populations, indicating a limited range of climatic conditions tolerated by desert tortoises (Luckenbach 1982; Morafka and Berry 2002). Although a variety of tortoise species can tolerate the hydric conditions of arid environments (Minnich 1976), there appears to be a Family-wide limit to these tolerances at approximately 100 mm rainfall per year (Morafka and Berry 2002). An ecological test of these limits in the desert tortoise appears to be demonstrated by the rarity of desert tortoises in Death Valley and the absence of desert tortoises from Saline and Eureka Valleys in Inyo County, California (Morafka and Berry 2002), where mean annual precipitation accumulations on the valley floors range from approximately 40 to 100 mm annually. Luckenbach (1982) reported that the most favorable desert tortoise habitats within California included areas that received 50 to 200 mm of annual rainfall.

The Mojave Desert is the driest ecosystem in North America, with annual precipitation accumulations ranging from 50 to 130 mm in desert valleys and up to 250 mm or more on mountain ranges. The majority (50-70%) of annual precipitation falls during winter (November through March), when large-scale fronts of moisture originating over the northern Pacific Ocean push southward with fluxuations in the jet stream. These low pressure systems generally produce widespread, steady, and relatively light rains that deeply saturate desert soils, favoring germination of winter annual herbaceous plants – the food of desert tortoises and many other desert herbivores and granivores. In the eastern Mojave Desert, the jet stream influence is less pronounced than further west, and winter precipitation accumulations are smaller (Hereford and Webb 2004). Levels of wet season precipitation and annual biomass production play a significant role in desert tortoise movement and activity patterns (Duda et al. 1999), growth (Medica et al. 1975), and survival (Longshore et al. 2003). Inter-seasonal variability and unpredictability of precipitation patterns can be quite pronounced. For example, the winter of 2004-2005 was one of the wettest seasons on record since the winter of 1940-1941, an El Niño year. Bracketing this exceptional rainfall year is the 2005-2006 winter, which is was one of the driest winters on record, and the 2001-2002 winter season, which is the driest on record. Multi-year droughts occur at least once or twice per 100 years, or 10-20 times per 1,000 years. Thus, the unpredictable nature of precipitation availability may have significant implications for desert tortoise survivorship and population dynamics.

Summer precipitation is an important habitat component. Though dry season precipitation does not contribute significantly to annual biomass production (Beatley 1974), observations indicate that summer rains that provide drinking opportunities may be critical for tortoise survivorship, particularly during drought years (Nagy and Medica 1986). Furthermore, dry season drinking opportunities are important for maintaining typical activity and growth during a year (Henen et al. 1998; Longshore et al. 2003). The North American Monsoon produces an annual summer precipitation pattern in the American Southwest that includes cells of moisture that are energized as they pass over the Gulf of California and are filtered northward along the Sierra Madre Occidental before spilling northward across the states of Sonora, Mexico, and Arizona and New Mexico, USA (Gutzler et al. 2005). The North American monsoon provides a precipitation pattern that supports the relatively mesic Sonoran Desert of northern Sonora and southwestern Arizona and the Chihuahuan Desert of northern Chihuahua and New Mexico. Though centered to the east, the North American Monsoon's influence extends westward into the Mojave Desert, producing a summer precipitation gradient from east to west. Monsoonal storms in the Eastern Mojave subregion are more frequent and intense (resulting in higher summer precipitation accumulations) compared to the storms characteristic of the Western Mojave. Hereford et al. (2004) placed the dividing line differentiating rainfall patterns at the 117° longitude meridian, with the majority of annual precipitation occurring during the winter season west of the meridian and a bi-seasonal precipitation pattern east of the meridian due to greater summer precipitation accumulations. Rainfall accumulates more quickly during monsoonal events, averaging approximately 2.0 mm per hour, compared to winter season events that provide rates of approximately 0.8 mm per hour (Redmond 2009). However, monsoonal cells are small and spotty in distribution (Went 1948), with typical diameters between 2 and 5km (Redmond 2009). Desert heat and winds are drying agents that quickly dissipate monsoonal rains unless they are relatively long in duration. The differential availability of summer water resources to desert tortoises may have important implications for population dynamics.

2.5.3 Soil

Because desert tortoises are burrowing chelonians, soil types are a limiting constraint to their distribution within the Mojave Desert. Luckenbach (1982) reported that desert tortoises occupied areas characterized by soil types varying from gravelly flats to sand soil with some clay, to fine windblown sand and stabilized dunes. He reported that the most favorable habitats within California were characterized by sandy loam or light gravelly clay soils that provided good burrowing habitat, and that tortoises are absent or scarce in most windblown sand areas (Luckenbach 1982). Andersen et al. (2000) found that higher tortoise densities were encountered in areas with loamy soils.

2.5.4 Vegetation Communities

Desert tortoises typically occupy habitats dominated by creosote bush scrub at lower elevations, and blackbrush scrub and juniper woodland ecotones at higher elevations (Germano et al. 1994). Luckenbach (1982) reported that the most favorable habitats within California contained a high diversity of perennial plant species and high production of annual plant (forage) species. Desert tortoises in California are mostly distributed among four communities, including creosote scrub, cactus scrub, saltbush scrub, and Joshua Tree woodland, but are most commonly found in desert scrub vegetation communities dominated by creosote (Luckenbach 1982).

2.5.5 Microhabitats

Desert tortoises use cover sites such as soil burrows, pallets, and caliche caves (Bulova 1994; O'Connor et al. 1994). Tortoises hibernate, aestivate, or rest in subterranean burrows or caves, spending as much as 98 percent of their time underground (Marlow 1979; Nagy and Medica 1986). Surveys at two sites on

Fort Irwin (Berry 1999) indicate that caliche caves were a much more important retreat site than soil burrows, with 68.9 percent and 60.6 percent of tortoises occurring within caliche caves, as opposed to 16.2 percent and 12.1 percent within soil burrows. Caliche is a calcium carbonate ($CaCO_3$) soil horizon commonly observed as resistant layers within alluvium or as hardpan in arid environments such as the Mojave Desert. The formation of caliche results from the precipitation of calcium carbonate in lower horizons of arid and semi-arid soils (Marion et al. 1985; Schlesinger 1984). Because of the hardness of caliche lenses, burrows or caves excavated under them are more stable and last much longer than soil burrows. Additionally, caves situated below caliche lenses are typically considerably longer and deeper than soil burrows because of the strength of the lens. Recent evidence suggests that when caliche caves are available, they are very important retreat sites—particularly during hot summer and cold winter inactivity periods—and are disproportionately used over soil burrow sites (Goodman et al. 2009).

Desert tortoises select cool, deep cover sites to minimize evaporative water loss and maintain body temperatures below daytime ambient surface temperatures (McGinnis and Voigt 1971; Zimmerman et al. 1994). By resting in subterranean retreat sites during the hottest portions of the day, desert tortoises not only avoid surface temperatures that would lead to overheating and death, but also enter microclimate with relatively higher humidity (Bulova 2002; Wilson et al. 2001). Bulova (2002) demonstrated that humidity was greatest and tortoise evaporative water loss was lowest while tortoises resided in subterranean shelters. Tortoises can behaviorally manipulate the humidity levels within their burrows by facing inward and forming a pocket of relatively moist air in the back of the burrow as exhaling causes respiratory water loss (Bulova 2002). Under only two conditions is humidity greater above the ground surface: during periods of rain and at night (Bulova 2002). During the summer, tortoises will often spend the night above ground (Nagy and Medica 1986; Zimmerman et al. 1994), presumably to reduce rates of evaporative water loss in the relatively humid microhabitat on the ground surface, but also to lower their core body temperatures (McGinnis and Voigt 1971). In addition to excavating and retreating to burrows, desert tortoises use and modify subterranean caves – primarily caves formed or excavated beneath caliche deposits, but also granitic and sandstone rock shelters. Caliche caves are relatively more extensive than burrows and support a microhabitat that has consistently and uniformly higher humidity levels and cooler temperatures relative to soil burrows, particularly because they are longer (Bulova 2002), but also because they may be deeper and more thermally protected.

Foraging and drinking sites are likely important microhabitat components. Baxter (1988) examined habitat use by desert tortoises at Twentynine Palms, and determined that tortoises preferred placing burrows at the edges of washes and vegetation community ecotones, suggesting that tortoises positioned burrows close to rich foraging areas. Jennings (1997a) observed tortoises within habitats that supported preferred forage along washlet margins. Finally, washlets on hillsides, flat boulder exposures, and other areas where water accumulates provide important drinking features during rain events and are an important microhabitat characteristic for desert tortoises in the Mojave Desert.

2.6 Daily and Seasonal Activity

2.6.1 Activity/Dormancy Periods and Environmental Cues

The daily and seasonal activities of desert tortoises are largely driven by the harsh climate of the Mojave and Colorado Deserts, particularly extremes in temperature and low water availability. During the summer, surface temperatures may exceed 50°C (122°F), whereas winter temperatures regularly fall to -10°C (14°F). Winter droughts that result in failure of germination of spring annual plants are fairly common, and summer precipitation events that provide drinking opportunities (late summer monsoonal storm cells) are rare and spotty in distribution. Tortoises mediate the effects of these conditions with a suite of behavioral, morphological, and physiological adaptations. Behavioral adaptations to the harsh

desert climate include excavation of and retreating to burrows or caves in order to escape extremes in temperature and aridity (Bulova 2002; Morafka and Berry 2002); early summer aestivation (Nagy and Medica 1986); an array of behaviors that maximize the ability to drink water during late summer monsoonal rains (Medica et al. 1980; Nagy and Medica 1986); and hibernation during winter months (Nussear et al. 2007). An important morphological adaptation is an enlarged urinary bladder characteristic of gopher tortoises. Physiological adaptations include the ability to store water for physiological processes in the urinary bladder (Minnich 1976; Nagy and Medica 1986), a tolerance for high plasma and urinary bladder osmolality during periods of drought and negative water flux (Nagy and Medica 1986; Peterson 1996), and the ability to lower their metabolic rate during periods of drought (Peterson 1996; Henen 1997, 2002; Henen et al. 1998) and hibernation (Nagy and Medica 1986; Peterson 1996; Henen et al. 1998).

Tortoises begin their spring activity period upon emergence from hibernacula. Emergence dates for tortoises in the eastern Mojave Desert ranged between February 11th and April 27th with an average emergence date of between March 15th and 25th (Nussear et al. 2007). At Yucca Mountain in the eastern Mojave Desert, most tortoises exited hibernacula over a six-week period between mid-February and mid-April (Rautenstrauch et al. 1998). In the western Mojave Desert, tortoises emerged from hibernacula between March 1st and April 20th (Burge 1977). Juvenile tortoises emerge earlier than adults. The average date that juvenile tortoises smaller than 100 mm carapace length exited hibernation was February 28th; for immature tortoises (100-180 mm carapace length) March 21st; for adult females March 18th; and for adult males March 26th (Rautenstrauch et al. 1998).

After emerging from hibernation, the behavior of the tortoises appears sluggish for several days as they spend most of their above-ground time basking at the entrance to their cover site. Movements to other burrows are infrequent during this post-emergent period. Burge (1977) reported that the frequency of burrow changes did not meet pre-hibernation levels until mid-April. Tortoises are most active between mid-April and mid-May, a period when they forage on spring annual plants. Tortoises maintained in enclosures in the western Mojave Desert exhibit bi-modal daily activity in May, emerging to forage between 7:00 and 8:45 am; retreating to cover sites to escape mid-day temperatures between 9:15 and 10:50 am; emerging for a second foraging period between 4:30 and 6:00 pm; and retreating to cover sites for the evening between 5:50 and 6:30 pm (McGinnis and Voigt 1971). The succulent spring annuals provide tortoises with an abundance of water, which they accumulate in their urinary bladders, but potassium levels increase in the bladder and blood plasma as well, leaving them osmotically stressed (Nagy and Medica 1986). By mid-May most forage species have senesced and dried, and the activity of the increasingly dehydrated tortoises declines substantially.

For approximately 60-65 days between mid-May and mid-July, temperatures soar and water availability – either from wet annual plant biomass or rain – is negligent. Tortoise activity declines significantly during this period, and most individuals during most years enter a period of dormancy called aestivation. Tortoises aestivate as they dehydrate, accumulate high potassium concentrations in their urinary bladder and blood plasma, and attain high blood plasma osmolality (Nagy and Medica 1986; Peterson 1996; Henen et al. 1998). During the summer aestivation period, desert tortoises limit their activity levels (Nagy and Medica 1986; Peterson 1996; Duda et al. 1999), and are able to lower their metabolic rates (Peterson 1996; Henen et al. 1998), thus conserving physiological water requirements and energy. Compared to other reptiles, desert tortoises exhibit relatively low metabolic rates (Peterson 1996); however, metabolic rates vary considerably between tortoises within the same population and between years, suggesting that plasticity in the behavioral and physiological regulation of metabolic rates based on environmental factors is critical to the survival of the species (Henen et al. 1998).

Mid-summer thunderstorms produced by the North American Monsoon between early to mid-July and September bring relief in the form of intense but sporadic, patchily distributed, and short-lived rainfall events. Desert tortoises are typically activated from aestivation when these monsoonal storms provide

opportunities for drinking. The amount of rainfall that accumulates during a monsoonal storm may be an important factor for activating aestivating tortoises to emerge and drink. Minnich (1977) reported that a storm that resulted in 12 mm of rainfall activated tortoises, but a storm that resulted in 4.7 mm did not activate tortoises to drink. Nagy and Medica (1986) reported that 91% of the tortoises in their sample emerged to drink during a storm that yielded 4.8 mm of rainfall. Upon emergence from aestivation, tortoises typically drink between 10% (Nagy and Medica 1977) and 20% (Nagy and Medica 1986) of their body weight during July and August monsoons, but copious drinking that resulted in uptake of more than 40% of body weight has been recorded (Miller 1932). When tortoises are able to drink during monsoonal events, they flush their bladders of the hypo-osmotic, concentrated solution of urine and potassium and store large amounts of dilute urine, and blood plasma levels return to normal osmality (Nagy and Medica 1977, 1986; Peterson 1996). This in turn allows tortoises to break free of the drought-induced aestivation, and return to normal activity levels so that they may forage on dry plant material, metabolize the dry food using water resorbed from the bladder, and attain positive net annual energy (Nagy and Medica 1977; Peterson 1996; Henen 1997).

Desert tortoises exhibit a variety of behaviors that maximize their intake of water during monsoonal rain events. Tortoises will drink from surface features that pool or collect water, such as large flat rocks, small basins, or rivulets draining hillsides, and will return to these features in anticipation of acquiring a drink when monsoonal storms are in the area (P. Woodman, personal communication; M. Tuma, personal observation), presumably because they were successful in drinking from that feature previously. Desert tortoises also have the ability to 'lick' water from rock surfaces (Luckenbach 1982). Tortoises also suck water from recently saturated sand, and will push their beaks into the soil to drink in this manner (M. Tuma, personal observation). When drinking from pools of water that form within depressions in the soil, tortoises use their forelimbs to excavate sediments from the pool, forming a deeper 'catchment' (Medica et al. 1980). As more rain water collects within the basin the tortoises extend their drinking periods, thus increasing their access to water and the opportunities to more fully flush their urinary bladders. Tortoises have also been observed digging catchments as storms approached (Nagy and Medica 1977).

In the eastern Mojave Desert where the monsoon influence is stronger, rains provide for the germination of a diversity of summer annuals that are consumed by tortoises. In the absence of summer annuals, tortoises will consume dried, senesced spring annuals following drinking and rehydration. Peterson (1996) calculated annual energy utilization for desert tortoises, which indicated a net loss of energy from the consumption of succulent spring annual forbs alone. This suggests that tortoises require the additional dry vegetation during summer months to overcome the energy deficit. Since tortoises are hindgut fermenters, any source of plant material – even dried forbs and grasses – can provide energy. However, the dry plant matter can only be digested following rehydration during summer monsoons and resorption of water from the urinary bladder. Thus, the use of the bladder as a physiological water reservoir is essential not only to water economy, but also the annual energy budgets of desert tortoises.

Desert tortoises remain active until late October, when most enter a second dormancy period – hibernation. Tortoises at Yucca Mountain in the eastern Mojave Desert typically entered hibernacula cover sites during October through early November (Rautenstrauch et al. 1998). In the western Mojave Desert, tortoises entered hibernacula between October 26th and November 11th (Burge 1977). The timing and duration of hibernation appears not to be driven by external cues such as temperature, and may be a function of endogenous conditions (Nussear et al. 2007). Juvenile tortoises in the central Mojave Desert generally selected hibernacula within burrows with entrances that faced south or southeast, which apparently allow them to more effectively thermoregulate during the winter (Hazard and Morafka 2004). Woodbury and Hardy (1940; 1948) documented a pattern of behavior in the eastern Mojave Desert whereby tortoises tended to congregate (in groups of up to 17) in large dens (caliche caves) located in wash banks during winter hibernation. They determined that these caves maintained a narrow temperature range (51°-57°F) that approximated the mean of the much more widely varying surface temperatures during the winter months (Woodbury and Hardy 1948).

Tortoises in the northeastern portion of the species' range may hibernate for as long as six months (Woodbury and Hardy 1948; Bury et al. 1994). Nussear et al. (2007) reported hibernation periods of between 106 and 182 days for tortoises in the eastern Mojave Desert, with tortoises generally hibernating longer at sites situated at higher elevations where temperatures were cooler. Mean body temperatures for hibernating desert tortoises ranged from 11.4 to 16.0°C in the eastern Mojave Desert (Nussear et al. 2007). Tortoises may exit hibernacula sites to bask at burrow entrances during warm winter days (Woodbury and Hardy 1948; Nagy and Medica 1986; Wilson et al. 1999). Juvenile tortoises in the central Mojave Desert fed during warm winter days, though this behavior was rare (Wilson et al. 1999).

2.6.2 Movements and Behaviors

Home Range and Burrow Use Patterns

Desert tortoises occupy home ranges that include cover sites, mates, mineral salt licks, and drinking sites (Berry 1986a). Tortoises have a "remarkable" knowledge of the locations of resources within their homes ranges, and often travel along well-worn paths (Berry 1986). Arguably the most important resources within the home ranges of tortoises are cover sites, particularly burrows and caliche caves. Not only do cover sites offer protection from extreme temperatures and predators, but they also serve as nest site locations and centers for social interactions among tortoises, particularly mate-seeking. There are considerable differences in the numbers of cover sites and areas used by tortoises within different age and sex classes. Males, in particular, typically use more cover sites, cover greater distances, and use larger areas as they search for females to court and copulate with.

Harless et al. (2009) reported that male tortoises in the central Mojave Desert used an average of 15.4 and 16.3 cover sites in consecutive years; females used an average of 11.4 and 12.4. Franks et al. (2011) tracked adult female tortoises at two sites, and reported that females at an eastern Mojave Desert site used an average of 4.5 and 5.4 burrows in consecutive years, whereas females at a central Mojave Desert site used an average of 4.3 burrows in one season. Rautenstrauch et al. (2002) reported that male and female tortoises each used similar numbers of burrows per season (range of 6-22 for males, 4-23 for females) over a three-year study site in the eastern Mojave Desert. Bulova (1994) reported that adult tortoises at an eastern Mojave Desert site used an average of 9.1 burrows per activity season, switched shelters an average of 11.3 times, and spent an average of 1.7 days at each shelter. Females switched burrows more times than males in June, but males switched burrows more frequently and used more cover sites than females in August and September.

Bulova (1994) reported that male and female tortoises travelled distances between burrows that ranged from 0.4 – 644.5 m, with an average of 148.9 m. Franks et al. (2011) reported mean distances travelled between successive captures for tortoises monitored throughout the Mojave Desert; mean distances travelled by females ranged from 48 to 198 m at six study sites while males travelled mean distances of between 200 and 298 m at three study sites. Far less is understood about the dispersal movements of desert tortoises. Berry (1986) provides anecdotal accounts of adult, subadult, and juvenile desert tortoises making long-distance movements ranging from 1,400 to 7,300 m that were accomplished over periods ranging from days to years.

Bulova (1994) observed that most burrows were used singly during the seasonal activity period, with the exception of late July through September, when male-female co-occupancy of burrows was common, and October, when same-sex and opposite-sex co-occupancy were each common. Similarly, Burge (1977) reported that male-female co-occupancy of burrows was common in August and September. Females only shared burrows during the hibernation period (Burge 1977; Bulova 1994), suggesting that they are territorial toward other females during other parts of the year. Woodbury and Hardy (1948) documented a pattern by which tortoises at a site in the eastern Mojave Desert generally congregated in caliche caves

located in wash banks during winter and moved to soil burrows located on flats and benches during the summer activity period. Burge (1977; 1978) reported that tortoises used between 12 and 25 shelter sites per year at an eastern Mojave Desert site, and that 75% of the shelter sites used by an individual were used by other tortoises. Bulova (1994) reported that tortoises used between 3 and 18 shelter sites during an activity season, but that an average of just 35% of shelter sites used by an individual were used by other tortoises. Harless et al. (2009) analyzed the degree of overlap of home range areas and "core" areas and found considerable male-female and male-male overlap, but not female-female overlap. Male tortoises cohabited burrows with other males nearly equally as they did with females, and females almost exclusively cohabited burrows with males only. The authors suggested that a female-based territoriality system would explain their observations. Females may passively avoid each other's use areas. Bulova (1997) reported that during the nesting season, females avoided using burrows where other females had deposited scats.

Previous studies of home range in desert tortoises have determined a consistent pattern of males using larger areas than females. Home range areas used seasonally by desert tortoises generally vary between 20 and 53 ha for males and between 5 and 21 for females as determined using the Minimum Convex Polygon (MCP) technique (Table 2).

Table 2. Home range areas used by desert tortoises at several Mojave Desert study sites.

Study Site Location	Males	Females
Eastern Mojave Desert (DTCC) O'Connor et al. (1994)	20.9 ha	9.0 ha
Eastern Mojave Desert (Beaver Dam Slope, AZ) Hohman and Ohmart (1980)	23 ha	11 ha
Eastern Mojave Desert (Arden, NV) Burge (1977)	32.3 ha	14.8 ha
Eastern Mojave Desert (Ivanpah Valley, CA) Franks et al. (2011)	-	9.7 ha, 7.6 ha
Central Mojave Desert (Ft. Irwin Reference Site, CA) Franks et al. (2011)	-	5.3 ha
Central Mojave Desert (Ft. Irwin) Harless et al. (2009)	39.4 ha, 47.4 ha*	13.8 ha, 16.9 ha*
Southeastern Mojave Desert (Joshua Tree NP) Freilich et al. (2000)	43.5 ha	9.7 ha
Northern Mojave Desert (Argus, CA) Berry (1974)	53 ha	21 ha

*Two values represent two consecutive years.

Duda et al. (1999) provided an important comparison of tortoise space use and activity during productive and drought years, and documented a pattern of depressed activity during drought years. Home range sizes were significantly smaller for both male and female tortoises during a drought year (Table 3). Additionally, the mean numbers of burrows used was lower and mean distances travelled per day were shorter during the drought year. Franks et al. (2011) compared data across several studies and similarly determined that home range sizes of tortoises were smaller during seasons of lower precipitation accumulations.

Table 3. Comparison of home range areas used by desert tortoises during productive and drought years.

Climatic conditions	Males	Females
Productive year	7.7 ha (MCAGCC) 26.4 ha (JTNP)	7.3 ha (MCAGCC) 8.5 ha (JTNP)
Drought year	3.1 ha (MCAGCC) 6.7 ha (JTNP)	0.9 ha (MCAGCC) 1.9 ha (JTNP)

Source: (Duda et al. 1999)

Social Behaviors and Courtship

Desert tortoises are highly social animals, and communicate with each other using a repertoire of auditory, olfactory, visual, and tactile signals (Berry 1986). An important morphological feature unique to *Gopherus* species is the subdentary gland, a pair of which is located under the tortoise's beak in the area of the 'chin.' The subdentary glands are activated at sexual maturity and provide important visual and chemical cues for sex recognition and dominance for courtship and agnostic displays (Weaver 1970). Alberts et al. (1994) examined the function of the subdentary gland secretions in male desert tortoises and determined that the glands of dominant males were generally larger than those of subordinate males. The size of the glands changed throughout the season, becoming largest in late summer. The size of the glands was generally correlated with blood plasma testosterone levels. Subdentary gland secretions also serve identification or recognition, allowing tortoises of either sex to discriminate between familiar and unfamiliar individuals. Male tortoises use olfactory cues to follow female tortoises (Berry 1986; Black 1976), and olfactory cues also allow individuals to recognize each other, which is apparently important in maintaining and respecting dominance hierarchies. Fresh scats and urine of dominant males have been shown to cause subordinate males to avoid the area, at least in captive colonies (Nichols 1957; Patterson 1971). Both chin gland secretions and scats provide olfactory clues that allow tortoises to discriminate between burrows used by other tortoises (Bulova 1997). Visual signals are displayed during courtship and agnostic interactions, and include dominance signals such as head-bobbing, mouth gaping, and extending the neck and holding the head in an elevated position, and submissive signals such as shell dropping, withdrawing head and limbs into the shell, or retreat (Berry 1986). Tactile signals are also displayed during courtship and agnostic interactions, and include nose-touching, biting, shell ramming, hooking, and pushing (Berry 1986; Auffenburg 1977).

No other behavior involves as much communication between tortoises as courtship. During courtship visits, males position themselves outside of a burrow occupied by a female, face in, and bob their heads (Bulova 1994). Females may be enticed from the burrow or retreat further inside. Her response may be dependent on her previous experiences with the male (Berry 1986). The male may cohabitate within the female's burrow until she exits, at which time he trails her and attempts to court her (Burge 1977; Bulova 1994). Courtship rituals typically involve a male trailing a female, and attempting to get her to submit with a series of increasingly dominant displays. He repeatedly circles her, bobbing his head and touching her head and shell with his nose (Black 1976). If the female moves away, the male trails her and moves quickly to overcome her, displaying more vigorously his head bobbing (Berry 1986; Black 1976; Ruby and Niblick 1994). At this point the female may begin circling to get around the male, and the male responds with more intense head-bobbing, and biting and ramming her shell (Black 1976; Ruby and Niblick 1994). The circling actions by both male and female leave a tell-tale 'courtship ring' impression in the sediments that contains the tracks of each tortoise (Woodbury and Hardy 1948). The female submits when she stops moving, and the male mounts her, grunting and hissing as he does so (Black 1976; Ruby and Niblick 1994). If the male is considerably larger than the female, he may engage in a more forcible insemination through physically overpowering her. For pairs that are more equally sized, visual and tactile signals elicited by the male likely play a larger part in eliciting the female's submission.

As the male positions himself atop the female, he rams the posterior portion of his plastron against the posterior portion of the female's carapace (xiphiplastral ramming, Auffenberg 1977). A receptive female will extend her head and move it back and forth in a horizontal swinging motion (Ruby and Niblick (1994). Copulation is attained when the male places his tail under her carapace, positions his cloaca against hers, inserts his penis, and deposits his sperm. The female may try to move away during the process, which may result in the male falling off of her (Black 1976). Courtship ceases when the female is able to move away, typically after the male falls from the mounted position (Black 1976).

The desert tortoise mating system is best described as promiscuous (Burge 1977). Berry (1986) reported that males attempt to mate with every female they encounter. Davy et al. (2011) determined that the majority (64%) of reproducing females were polyandrous, which resulted in most (57%) of their clutches being sired by multiple males. The sperm storage capabilities of female desert tortoises (Gist and Jones 1989; Palmer et al. 1998) likely facilitate multiple paternities within clutches. Niblick et al (1994) postulated that because larger males are more successful at mating attempts, female choice may have a role in their outcome. Forced insemination may be possible for large male desert tortoises (Berry and Shine 1980), though female cooperation appears to result in more successful matings (Niblick et al. 1994).

Male-male combat is a prominent feature of desert tortoise sociality, and male dominance hierarchies are established within local populations. The hierarchy is largely determined by body size, with the largest males generally being the most dominant (Berry 1986; Niblick et al. 1994). However, prior interactions between males and residency have an effect on the outcomes of agnostic interactions between males as well (Niblick et al. 1994). Males often engage in combat when they encounter each other during mating season (Burge 1977; Berry 1986; Bulova 1994), typically in August and September, when blood plasma testosterone levels are highest (Lance et al. 2001; Lance and Rostal 2002). While males do not defend specific, discrete territories, they may enjoy a "home court" advantage when males of different residency status meet (Niblick et al. 1994). During combat males begin by head-bobbing and positioning themselves high on their legs as they approach each other (Ruby and Niblick 1994). Tactile communication begins with the males sniffing each other, which escalates to biting each other's shells, which escalates to frontal ramming (Ruby and Niblick 1994). Extended ramming episodes can lead to the anterior ends of both males being propped up (Ruby and Niblick 1994). One of the males may retreat at any point in the combat episode, but if a male retreats following frontal ramming, the other male may ram him from the rear, hooking his underside with his gular horn and lifting the retreating male off of the ground (Ruby and Niblick 1994). If a male is flipped either during frontal ramming or by being hooked, he waves one of his front limbs in a tight circle, which often elicits the other male to continue ramming, often righting the flipped male (Ruby and Niblick 1994). If the male that has been flipped is not righted after continued ramming from the dominant male or if he cannot right himself, death from overheating may ensue.

2.7 Community Ecology

2.7.1 Forage Species

Desert tortoises are herbivorous, consuming a diet of annual, perennial, and grass species. The majority of their diet consists of the succulent parts and blooms of spring annual plants. Annual production is dependent on winter precipitation events, and drought conditions often result in no production at all. Beatley (1974) determined that at least one storm that resulted in the accumulation of at least 25 mm was required between late September and early December (when surface soil temperatures are appropriate) for winter annual plant seeds to become physiologically active and successfully germinate in the spring in the northern Mojave Desert. Similarly, F. W. Went and his colleagues (Went 1948; Went and Westergaard

1949; Juhren et al. 1956) reported that early winter storms that produced at least 20 mm of rain were required to stimulate the germination of most winter annual species at Joshua Tree National Park. Longshore et al. (2003) reported that annual biomass production was positively and highly correlated with the amount of wet season precipitation. An additional important cue for the germination of winter annuals is minimum temperatures ranging from 8 to 13° C (Went 1948; Went and Westergaard 1949; Beatley 1974). The winter annuals germinate by late March or early April; flower and fruit in April and May; and senesce by mid-May (Beatley 1974; Nagy and Medica 1986).

Oftedal (2002) listed major food plants of the desert tortoise that included: desert dandelion (*Malacothrix glabrata*), bright white (*Prenanthella exigua*), small wire lettuce (*Stephanomeria exigua*), forget-me-nots (*Cryptantha* spp.), combbur (*Pectocarya recurvata*), tansy mustard (*Descurainia pinnata*), beavertail cactus (*Opuntia basilaris*), pencil cholla (*Opuntia ramosissima*), rattlesnake weed (*Chamaesyce albomarginata*), desert spurge (*Chamaesyce micromera*), two-seeded milk-vetch (*Astragalus didymocarpus*), Layne's milk-vetch (*Astragalus layneae*), various lotus species (*Lotus* spp.), the introduced filaree (Erodium cicutarium), small-flowered blazing star (*Mentzelia albicaulis*), desert mallow (*Sphaeralcea ambigua*), trailing four-o'clock (*Allionia incarnata*), desert wishbone (*Mirabilis laevis*), sixweeks three-awn (*Aristida adscensionis*), sixweeks grama (*Bouteloua barbata*), introduced bromes (*Broums rubens* and *Bromus tectorum*), fluffgrass (*Erioneuron pulchellum*), bush muhly grass (*Muhlenbergia porteri*), Indian ricegrass (*Achnatherum hymenoides*), galletta grass (*Pleuraphis rigida*), the introduced Mediterranean grass (*Schismus barbatus*), and slender fescue (*Vulpia octoflora*).

Jennings (2002) determined that ten plants at the DTNA in the western Mojave Desert accounted for more than 80% of bites taken by tortoises in the sample: Hairy lotus (*Lotus humistratus*), desert four o'clock (*Mirabilis bigelovii*), rattlesnake weed, Layne's milk-vetch, bright white, two-seeded milk-vetch, Booth's evening primrose (*Camissonia boothii*), filaree, brittle spineflower (*Chorizanthe brevicornu*), and lacy phacelia (*Phacelia tanacetifolia*). Desert tortoises were selective for certain parts of each food plant, and the blooms of food plants were available at different times according to their phenology, indicating that tortoise diets and preferences changed throughout the feeding period (Jennings 2002). Desert tortoises inhabiting sites in the eastern Mojave Desert consumed three-awn grasses (*Aristida* spp.), slim tridens grass (*Tridens muticus*), bush muhly grass, the introduced red brome grass (*Bromus rubens*), and the perennial shrub globemallow (*Sphaeralcea* spp.) (Hansen et al. 1976). Though tortoises consume non-native grasses and forbs, native plants provide better nutrient and water balances (Nagy et al. 1998; Hazard et al. 2010). In particular, desert tortoises prefer plants that provide a high nitrogen to potassium (N:K) ratio, which may be difficult to attain with non-native plants (Oftedal and Allen 1996; Oftedal 2002; Oftedal et al. 2002). Animal feces, bones, and carcasses are often ingested by desert tortoises, apparently to supplement calcium intake (Hansen et al. 1976; Esque and Peters 1994; Jennings 2002; Walde et al. 2007). Additional calcium sources include stones, soil, and minerals (Esque and Peters 1994; Marlow and Tollestrup 1982). Finally, juvenile tortoises may opportunistically ingest insects (Okamoto 2002).

2.7.2 Cover Site Associates

Neonate, one-year-old, and small juvenile tortoises are capable of excavating burrows, but often use and modify rodent burrows, particularly those of kangaroo rats (*Dipodomys* spp.) (M. Tuma, pers. obs.). Larger juveniles have also been observed using and modifying the abandoned burrows of kit foxes (M. Tuma, pers. obs.). More often, the burrows excavated by tortoises are used by other animals, including a variety of insects and arthropods, numerous lizard and snake species, burrowing owls, poorwills, small rodents, lagomorphs, and kit foxes (Luckenbach 1982).

Perennial shrubs provide important shade resources for desert tortoise. Soil burrows are often excavated beneath perennial shrubs, which provide additional thermal protection. While on the surface outside of

burrow or cave sites, tortoises often retreat under the cover of shrubs. The creosote bush (*Larrea tridentata*), is the most common shrub species within the range of the desert tortoise, and is commonly used by tortoises for shade. Other shrubs commonly sought out for shade resources by desert tortoises include white bursage (*Ambrosia dumosa*), saltbushes (*Atriplex* spp.), cheesebush (*Hymenoclea salsola*), various ephedras (*Ephedra* spp.), desert senna (*Senna armata*), bladder pod (*Salzaria mexicana*), various desert thorns (*Lycium* spp.), blackbrush (*Coleogyne ramosissima*), and pencil cholla.

2.7.3 Predators

Canids, particularly coyotes (*Canis latrans*) and kit foxes (*Vulpes macrotis*) are major predators of desert tortoises, and are known to excavate and consume tortoise eggs from nests and tortoises from burrows. Karl (1998) reported that kit foxes were the dominant nest predators at the Ward Valley site. Similarly, kit foxes were implicated in the destruction of most depredated tortoise nests at the MCAGCC research site (Bjurlin and Bissonette 2004). Berry (n.d., mentioned in Turner et al. 1984) reported that 13 of 48 tortoises were killed by coyotes and kit foxes at a study site at China Lake. Other likely mammalian predators of desert tortoises include bobcats (*Lynx rufus*), skunks (*Mephitis mephitis* and *Spilogale putorius*), and badgers (*Taxidea taxis*) (Woodbury and Hardy 1948; Luckenbach 1982). Feral dogs are also known to be a significant predator of adult and subadult tortoises in the vicinity of urban areas.

A number of avian species are known or suspected to be predators of juvenile desert tortoises, including golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), loggerhead shrike (*Lanius ludovicianus*), greater roadrunner (*Geococcyx californianus*), burrowing owl (*Athene cunicularia*) and common raven (*Corvus corax*) (Luckenbach 1982; Berry et al. 2006).

Coachwhip snakes (*Masticophis flagellum*) are likely predators of both eggs and juvenile tortoises (Luckenbach 1982) and Gila monsters are known predators of tortoise nests. Gila monsters (*Heloderma suspectum*) prey on the eggs of desert tortoises, and occupy the burrows of female tortoises during the nesting season, apparently while in search of tortoise nests and eggs (Gienger and Tracy 2007). Female desert tortoises in southern Nevada vigorously defended their nest sites at or within burrows from Gila monsters (*Helodermata suspectum*) (Gienger and Tracy 2007).

2.7.4 Parasites and Disease

Desert tortoises are susceptible to infection by an array of microorganisms, most importantly the *Mycoplasma* bacteria that cause respiratory mycoplasmosis or Upper Respiratory Tract Disease (URTD): *Mycoplasma agassizii* and *Mycoplasma testudineum* (Brown et al. 1994; Brown et al. 2004). These bacteria are transmitted between tortoises during social encounters that feature stylized courtship, mating, and territorial defense behaviors involving face to face proximity, or during co-habitation of burrows and caves. Since only the adult, reproductively active members of the population are engaged in these behaviors, they are the age class most likely to transmit URTD (Wendland et al. 2010). Little is known about the transmission of URTD to juvenile tortoises; however, since tortoises of pre-reproductive age are not social, they are far less likely to become infected or to transmit the bacteria (Wendland et al. 2010). Antibody responses are generally much weaker in reptiles than in mammals; take much longer to produce (weeks vs. days); and may last much longer (months or years vs. days or weeks) (Origgi et al. 2007). Females that carry antibodies for *Mycoplasma* bacteria pass them to their ova, and they may be detected within neonate desert tortoises for a short period after hatching. The disease does not transmit vertically (Schumacher et al. 1999).

Berry et al. Berry et al. (2006) and Mack and Berry (2009) studied the epidemiological spread of URTD in the central and south-central Mojave Desert. Sampling of tortoises from the Ft. Irwin vicinity indicated that incidence of exposure to *Mycoplasma* bacteria, as evidenced by antibody titers determined using

ELISA, was higher in tortoises occupying areas closer to base offices, the Ft. Irwin cantonment, and paved roads (Berry et al. 2006). At the Daggett Site, Mack and Berry (2009) documented higher incidence of *Mycoplasma* exposure within segments of the populations that resided near human habitations and disturbances. Population segments at distances of up to 3 km from this "core" area of anthropogenic threats exhibited only slightly lower exposure rates. Mack and Berry (2009) surmised that the spread of *Mycoplasma* was facilitated by overlapping home ranges and the social nature of these animals, despite the distance and varying landscapes occupied by the population.

Sandmeier et al. (2009) point out that tortoises that test positive for antibodies to *Mycoplasma* exposure are not necessarily at risk for morbidity or mortality caused by URTD or mycoplasmosis. In fact, desert tortoises that have never been exposed to *Mycoplasma* may test positive to exposure to the pathogen due to high levels of "background" antibodies that are inherited as natural antibodies in the innate immune system (Hunter et al. 2008). As well, Sandmeier et al. (2009) state that although URTD has been implicated in population declines at certain localities (namely the western Mojave Desert), there is no evidence to suggest that the disease can cause high rates of mortality wherever it occurs, nor is there evidence to indicate that the disease occurs at epidemic levels. Other researchers have documented changes in antibody levels in animals over time, i.e., tortoises that tested "positive" for *Mycoplasma* antibody response at one time that later test "negative" for antibody response (Lederle et al. 1997; Brown et al. 1995). These results suggest that the virulence of *Mycoplasma* and antibody response in tortoises may vary both spatially and temporally, and that other environmental stressors such as drought may play a larger role in population response to the pathogen (Sandmeier et al. 2009). Thus, the ecological importance of mycoplasmosis or URTD in producing large-scale population declines may have been over-estimated.

Other tortoise infections are caused by viral, bacterial, and fungal organisms (Snipes and Biberstein 1982; Jacobsen 1994; Pettan-Brewer et al. 1996; Homer et al. 1998; Dickinson et al. 2001). The tick *Ornithodoros turicata* has long been recognized as a common ectoparasite of desert tortoises (Harbinson 1937; Woodbury and Hardy 1948; Ryckman and Kohls 1962).

3. DESCRIPTION OF THE MANAGEMENT AREA

3.1 MANAGEMENT UNITS

The Superior-Cronese management area for which this conservation analysis was developed is comprised of BLM-managed federal lands within the USFWS-designated Superior-Cronese Critical Habitat Unit (Figures 2a-2c). This area is situated over 629,697 acres in the central Mojave Desert and is located within the Western Mojave Recovery Unit (Figure 1). Six ACECs and two Wilderness Areas are wholly or partially included within this management area, including the Black Mountain Wilderness Area (20,935 acres), the Grass Valley Wilderness Area (32,841 acres), the Black Mountain ACEC (61,790 acres), the Rainbow Basin ACEC (4,102 acres), the Coolgardie Mesa ACEC (13,248 acres), the West Paradise ACEC (1,237 acres), the Parish's Phacelia ACEC (899 acres), and a portion of the Cronese Basin ACEC (2,440 acres). The management area also includes an archaeological park—the Calico Early Man Site (895 acres). The Superior-Cronese desert tortoise management area is characterized by substantial private land ownership, including 191 in-holdings distributed in a checkerboard-like fashion and totaling 224,744 acres. In addition, there are 19 state-owned in-holdings totaling 9,793 acres and two federally owned in-holdings totaling 8,690 acres. Eight of the private in-holdings (totaling 37,028 acres) are owned by conservancies, and nine of the state in-holdings (totaling 4,914 acres) are Ecological Reserves managed by the California Department of Fish and Game. Prominent land uses in the Superior-Cronese management area include OHV use, utility development, military activities, mining, and agriculture.

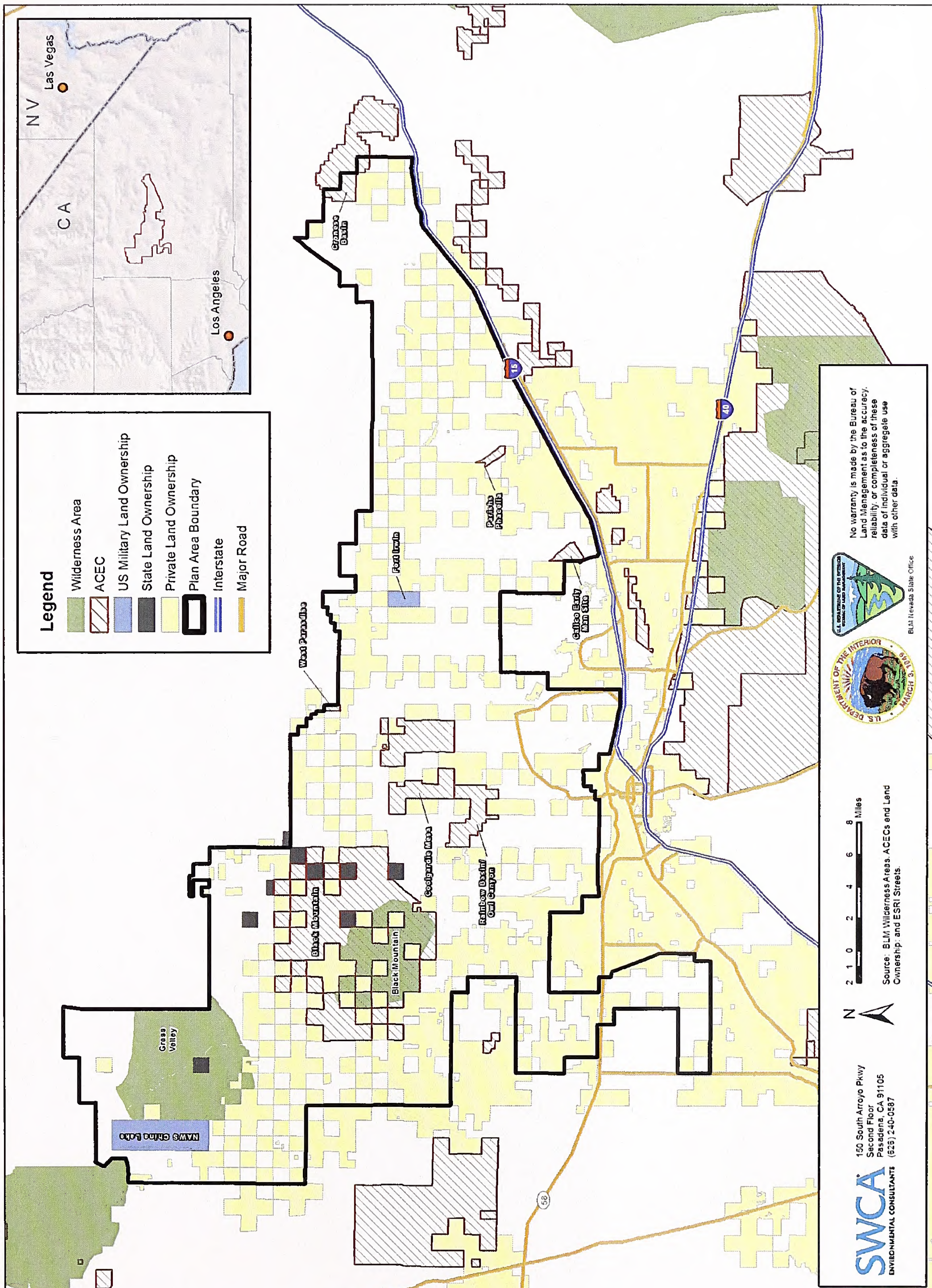

Figure 2a. Superior-Cronese Desert Tortoise Management Area.

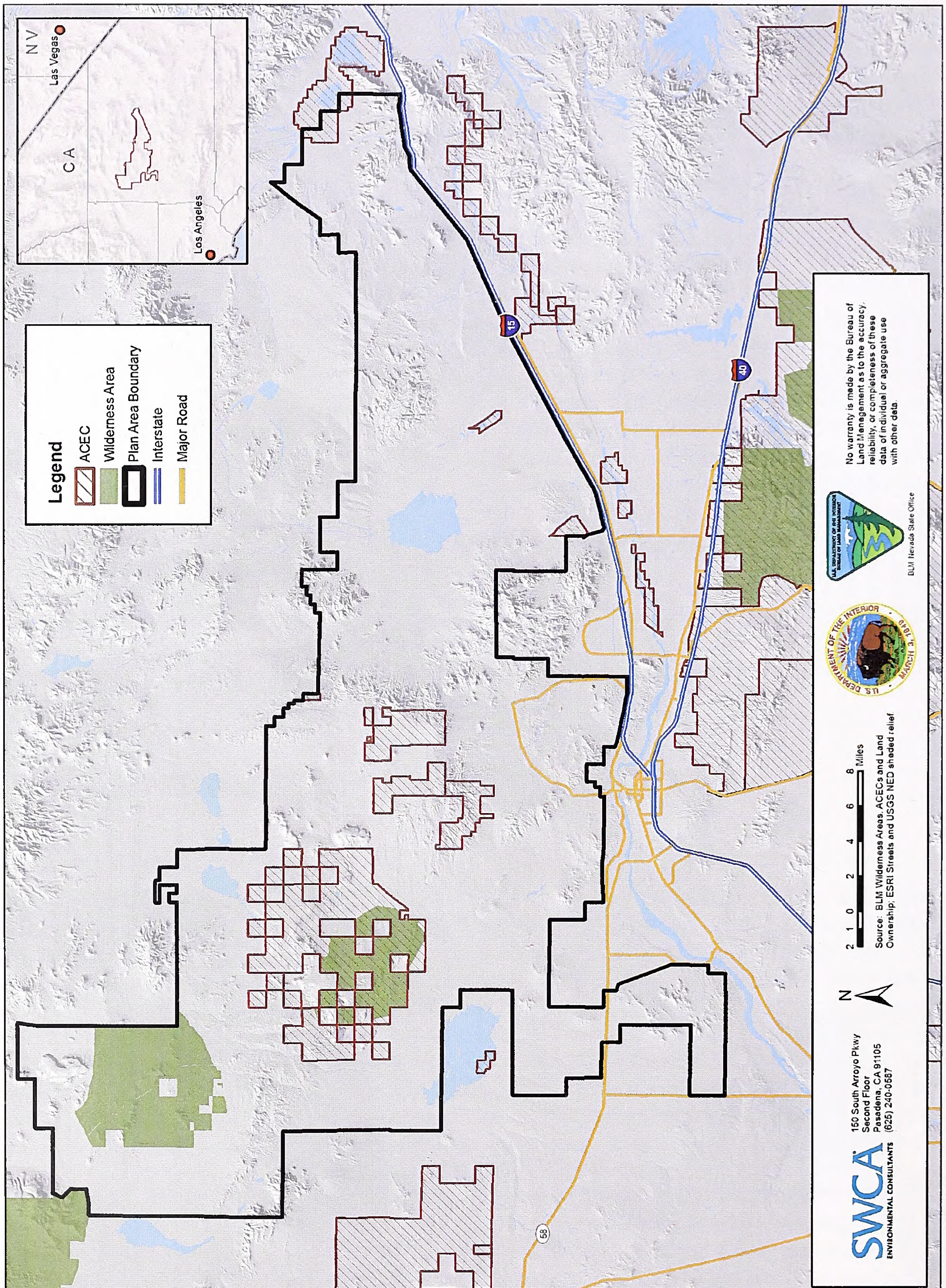

Figure 2b. Locations of ACEC and WA within the Management Area.

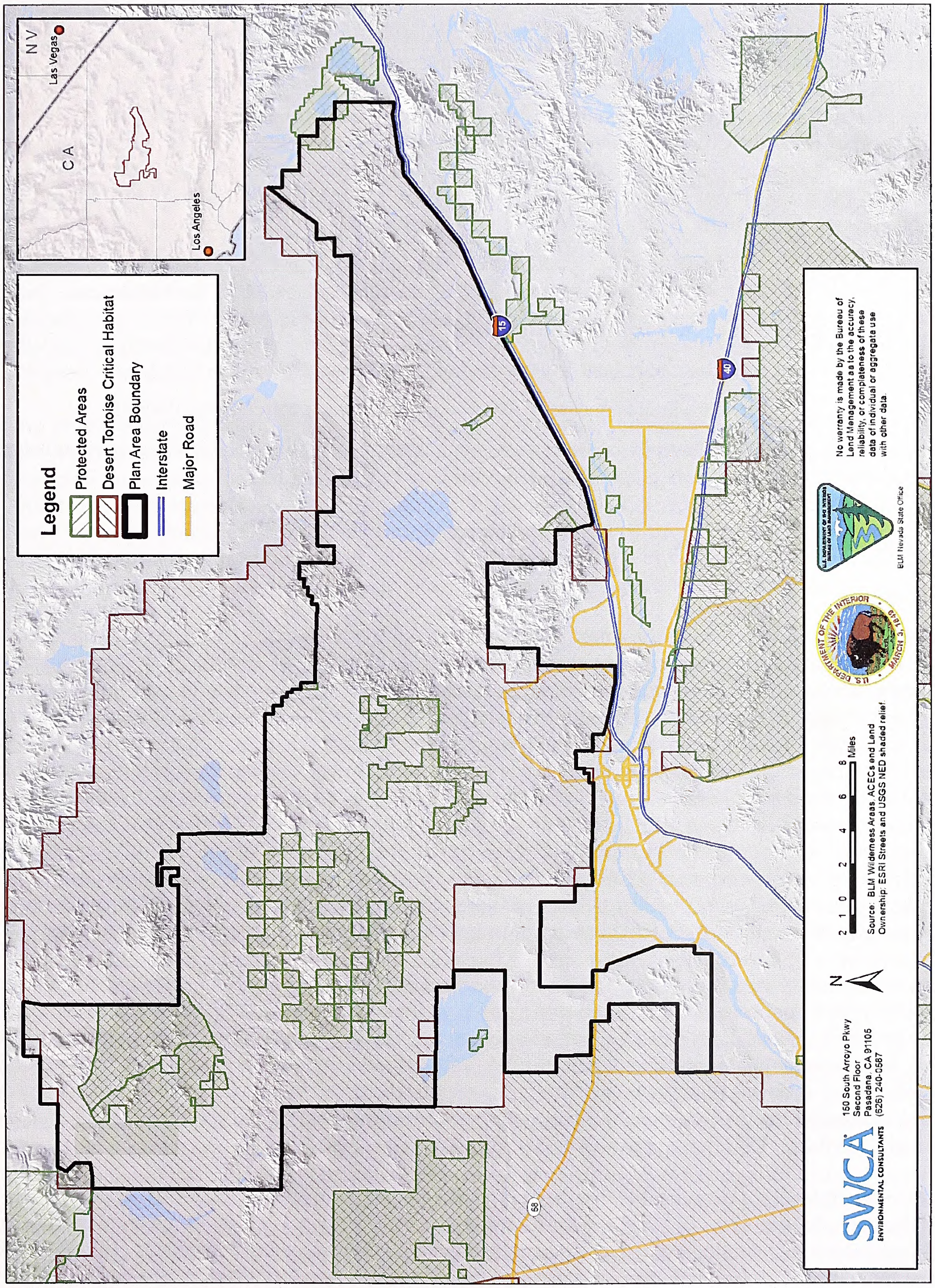

Figure 2c. Protected Lands within the Management Area.

3.2 Threats to Desert Tortoise Populations in the Management Area

The following discussion reviews the various threats to desert tortoise populations, including human developments (urbanized areas, roads, utility developments, etc.), human activities and by-products of activities (OHV use, military activities, mineral extraction, etc.), and biological and environmental threats (invasive plants, disease, subsidized predators, etc.). These threats are likely present in or directly adjacent to the Superior-Cronese management area, though in varying degrees of severity and distribution. The purpose of this section is to provide a review of the current knowledge of these threats in the context of the management area. A preliminary analysis of the distribution of these threats and their effects on tortoise populations within the management area is presented in Appendix A. The threats reviewed here are those that can be managed and/or mitigated by BLM land managers and biologists. Each is framed within the following context:

1) Does the threat cause direct mortality to tortoises?
2) Does the threat contribute to habitat loss, degradation, or fragmentation?
3) Does the threat facilitate human access to areas supporting desert tortoise populations?
4) Does the threat contribute to or otherwise interact with other threats, resulting in cumulative effects?

3.2.1 Human Developments

Urbanization

Urbanized developments are fairly common within the Superior-Cronese management area, and substantial developments are located immediately adjacent to it. The city of Barstow, California, situated immediately south of the management area, represents the most concentrated area of urbanized development. Other urbanized areas adjacent to or within the management area include those associated with the Interstate 15 corridor to the north and east of Barstow (including the communities of Yermo, Toomey, Harvard, Afton, and Cronese Valley), and the western limits of Barstow and the community of Lenwood along California Highway 58. There are three areas within the management area that support human developments, including low-density ranch communities in the vicinity of Harvard and Hinkley, and a number of ranches in the vicinity of Coyote Lake. The population of the city of Barstow has remained relatively stable between 1990 and 2010. However, with a population of between 21,000 and 25,000 during this period, plus population sizes of more than 10,000 in communities within and adjacent to the management area, the effects of urbanization are certainly present within adjacent desert habitats.

Urbanization not only converts native habitat in the immediate vicinity of the developed area, but also creates edge effects and habitat degradation that extends well into adjacent natural areas. The edge effects include transitions of soil characteristics, and vegetation and wildlife communities. Urbanized areas also facilitate human access into adjacent desert habitat, exposing desert tortoise populations to poaching, release of captive tortoises, attacks by pet dogs, deposition of garbage and litter and associated toxins, increased recreational activities, increased predation by subsidized species, and increased risk to disease (Berry and Nicholson 1984; Berry et al. 2006; Boarman 2002a).

Previous researchers have documented that desert tortoise populations in the vicinity of urbanized areas are particularly depauperate. In one extensive study across 90 square miles of undeveloped, non-agricultural habitat surrounding the city of Lancaster, California, Tierra Madre Consultants (1991) located only one live desert tortoise, and attributed that paucity of tortoise sign to indicators of human presence across the study area, including domestic dogs, trash/litter, shotgun shells/rifle cartridges, OHV tracks,

ravens, and evidence of sheep grazing. Edwards et al. (2004) attributed a suite of threats associated with urbanization, including domestic/feral dog attacks, vulnerability to disease transmission from escaped/released captive tortoises, and lack of immigration by other tortoises due to barrier effects of roads and other development to the near extirpation of Morafka's desert tortoise populations in the vicinity of Tucson, Arizona.

Roads

Several paved and major unpaved roads either bisect or border the Superior-Cronese management area, including Interstate 15, California Highway 58, Fort Irwin Road, Ghost Town Road, Calico Road, Alvord Mountain Road, Field Road, Powerline Road, Hinkley Road, Irwin Road, Helendale Road, Harper Lake Road, Phoenix Road, Lockhart Road, Hoffman Road, Black Canyon Road, Mule Canyon Road, Manix Trail, and numerous BLM routes. Heaton (2007) determined that areas with the highest counts (as measured by vehicle tracks per km) of graded roads in the management area were most often found adjacent to populated areas, particularly in the vicinity north of Barstow. Ungraded roads and trails occurred in moderate densities in the central portion of the management area.

One of the most important and best understood factors contributing to the degradation of the desert ecosystem is the proliferation of roads across the landscape. The effects of roads on both the physical and biological environment are numerous and well documented (Forman and Alexander 1998; Forman et al. 2003). Physical impacts include soil compaction, increased soil erosion, pollutant deposition, and increased noise pollution. Biological impacts include mortality of desert tortoises from vehicle strikes, changes to adjacent vegetation, spread of invasive plants, attraction of vertebrate predators, and barriers to dispersal. In addition, roads facilitate human access into areas supporting desert tortoise.

The impact of vehicular traffic along roads on desert tortoise–vehicle collisions has been studied throughout various portions of the Mojave Desert, with most studies indicating that vehicles are a major contributor to desert tortoise mortality. During three surveys conducted along California Highway 58 over a 2.5-year period, the remains of 39 dead tortoises were observed (Boarman et al. 1993; Boarman 1994). Boarman et al. (1993) reported finding the remains of 61 tortoises along 66 miles of highway edge along California Highway 58. Several studies have identified a 'mortality sink' or depression in desert tortoise population densities near roads. The area of influence that roadways have on desert tortoises varies greatly, and may depend on a variety of factors, including topography, vegetation characteristics, traffic volume, traffic speed, and tortoise densities (Boarman and Sazaki 2006). Nicholson (1978) reported a significant decrease in tortoise sign up to a distance of 1.6 km from a road, and determined that the road effect was magnified along roads that were constructed earlier (i.e. older roads) and had greater traffic volumes. Karl (1989) and von Seckendorf and Marlow (1997; 2002) report even greater zones of influence, identifying distances of up to 4.6 km and 3.2 km, respectively, from highways where tortoise populations were depressed. Additional studies have found less extensive zones of influence, including LaRue (1993), who observed a significant linear increase in tortoise sign as distance from the roadway increased up to a distance of 305 meters, and Boarman and Sazaki (2006), who determined that tortoise populations were depressed within a zone extending up to between 400 and 800 meters from California Highway 58. Von Seckendorff Hoff and Marlow (2002) suggest that, given the potential zones of influence beyond the actual road footprint that may negatively affect tortoise distribution, the cumulative impact of a road network may reduce the effective area of any conserved habitat. Furthermore, roads contribute to habitat fragmentation and in some cases, serve as barriers to dispersal and gene flow. Roads facilitate human access to natural desert areas where tortoises are collected or poached (Berry et al. 1996). Berry et al. (2006) conducted studies on Fort Irwin and found that the presence of infectious disease in tortoises was positively correlated with proximity to paved roads. Small wildfires of anthropogenic origin are frequently associated with roads (Brooks and Esque 2002).

Railroads

The Burlington Northern Santa Fe railroad crosses through the southern portion of the Superior-Cronese management area, near Interstate 15 and California Highway 58. Railroads are similar to roads as sources of mortality for desert tortoises. Tortoises may become caught between the tracks, causing them to overheat and die or be crushed by trains (USFWS 2011). Because of this, railroads are likely significant barriers to tortoise dispersal, and may contribute significantly to habitat fragmentation. Barriers to movement and population connectivity also have implications to exchange of genetic material, which can lead to inbreeding (Boarman and Sazaki 1996). Railroads likely contribute to the spread of invasive plants, and contribute to the deposition of toxins and pollutants in adjacent desert habitat.

Utility Development

Infrastructure associated with linear utility development includes electric transmission lines and towers, buried fiber optic cables, and buried pipelines carrying various liquids and gasses within a right-of-way or utility corridor. Utility infrastructure also includes developments such as substations, communications towers, and other non-linear structures. Six electric transmission corridors and three natural gas pipeline corridors run through the southern parts of the Superior-Cronese management area near Interstate 15, California Highway 58, and the Burlington Northern Santa Fe Railroad. Other utility corridors observed in the management area are associated with access roads or trails, and several are arranged in corridors that contain other linear features such as highways or railroads. Additional utilities observed within the management area include communication towers and other utilities distributed at discrete point locations. Most of these point utilities are associated with access roads that terminated at the utility location. Construction and maintenance of utility infrastructure contributes to tortoise mortality, habitat degradation, provides subsidies for predatory species, and encourages the spread of invasive plants. Access roads associated with utility developments facilitate human entrance into desert areas, and are often used by OHV recreationists.

Minimization measures enacted during construction projects mitigate take of tortoises; as a result, construction activities have relatively low potential to result in direct mortality. However, certain types of construction projects appear to result in greater take of tortoises than others. Olson (1996) compared various linear utility construction projects of similar lengths and locations, and determined that the number of tortoise mortalities on a natural gas pipeline project (n=29) was substantially more than mortalities on a fiber optic line installation project (n=1) and a transmission line construction project (n=3). Olson (1996) determined that the increased mortality events on the natural gas pipeline project were the result of increased traffic and desert tortoise-vehicle collisions associated with a higher rate of transport of building materials in support of this project. Tortoise mortality associated with utility corridors may also occur during maintenance of the utilities, as well as from tortoise–vehicle collisions along utility access roads. During the construction of pipelines, trenches opened for the placement or maintenance of pipes may serve as traps for tortoises and other animals (Olson et al. 1993).

The foundations of utility structures and road cuts associated with utility infrastructure may provide burrowing opportunities for desert tortoise, placing them at risk of harm during maintenance operations, the construction of new pipelines or power lines adjacent to existing corridors, or from road traffic along access roads. A study conducted at the Mesa wind park in the Colorado Desert demonstrated that desert tortoise burrows were commonly associated with anthropogenic features in the landscape, such as road cuts and concrete pads supporting electrical equipment (Lovich and Daniels 2000). Utility structures such as towers also help facilitate nesting by ravens and subsequent predation of tortoises if those areas did not have adequate nesting substrates before the new towers were erected (Boarman 1993). Juvenile tortoise remains have been detected underneath transmission tower sites; the predation event was linked to ravens (McCullough Ecological Systems 1995). Disturbances caused by grading and site preparation activities, and grading of access roads, provides a conduit for the spread of invasive plants introduced on

construction equipment (Zink et. al. 1995). Finally, construction and maintenance of utility facilities my introduce litter, toxins, and pollutants into adjacent desert environments.

Landfills

Numerous landfills are located within the Superior-Cronese management area. Two landfills are located in the northwest portion, and seven other landfills are distributed within the southern portion of the management area. Eighteen additional landfills are located within three miles of the management area boundaries. Landfills provide food subsidies to predatory species, particularly ravens and coyotes. They also result in the loss and degradation of desert tortoise habitat, introduction of litter, the spread of invasive plants and human access to desert areas.

The greatest impact of landfills is the subsidization of predators of desert tortoises, particularly ravens and coyotes (Boarman 2002a). Several studies (Boarman 1993; Boarman et al. 1995; Kristan and Boarman 2003) have documented the use of landfills by ravens, as well as their aggregations near, and movements from landfills into natural desert areas. Kristan and Boarman (2003) documented the greatest raven population densities in the western Mojave Desert at landfills and man-made ponds. Furthermore, they determined that the probability of raven attack on Styrofoam model tortoises approached 100% near landfills (Kristan and Boarman 2003). Landfills appear to be more important in subsidizing ravens than other anthropogenic sources of food and water (Boarman et al. 1995). The abundant food source provided by landfills likely allows raven individuals to survive in areas where natural sources of food are otherwise low in abundance, particularly during the summer and winter seasons (Boarman 1993). A constant food source from landfills contributes to higher breeding success rates for ravens and greater population sizes, which in turn likely results in increased risk of raven predation on juvenile tortoises.

Anthropogenic Water Sources

Anthropogenic water sources provide additional subsidies to predatory species. Additionally, their development contributes to loss of habitat and degradation of adjacent desert habitats by providing favorable conditions for the spread of invasive plants. There are plentiful anthropogenic water sources within and adjacent to the Superior-Cronese management area, including several ponds associated with human developments within and adjacent to the southern boundary. The urbanized areas in the vicinity of the management area provide limitless opportunities for water subsidies, particularly for ravens that can access puddles produced by irrigated lawns and other human activities involving water.

Water sources are scarce and ephemeral in undeveloped areas of the desert, and desert wildlife population sizes are likely limited by their availability. The availability of man-made water sources likely contributes to higher raven survivorship by providing water during periods of low availability, and allowing ravens to expand their range into parts of the desert that are isolated from natural sources of water. As with landfills, anthropogenic water subsidies likely contribute to raven population growth, thereby increasing predation pressures on local desert tortoise populations (Boarman 1993, Kristan and Boarman 2003).

3.2.2 Human Actions and Activities

Off-highway Vehicle Use

The Superior-Cronese management area is a popular destination for recreationists, particularly OHV users. Numerous trails proliferate throughout the management area, particularly adjacent to the communities within and along its southern border. Numerous BLM-designated Open Routes access a considerable portion of the management area, and illegal OHV use occurs in washes and "free play" areas adjacent to Open Routes.

The greatest impact to desert tortoise populations from OHV use is habitat degradation. OHV activity affects soils through the alteration of soil structure; the destruction of biotic soil crusts, abiotic soil crusts, and fine gravel surfaces that would otherwise stabilize soils; and soil erosion. Soil compaction is a common problem throughout the desert and is primarily caused by vehicles traveling across the desert surface (Webb 1982). In undisturbed conditions, soils typically have a high porosity and low bulk density (Froehlich et al. 1985). OHV travel has some effect on soil strength, which is affected by compaction, moisture content, texture, and bulk density (Adams et al. 1982a). These effects are primarily due to the disruption of the crust and vesicular layer (Webb 1982), whereby compaction of the soil makes it less porous, thus making it more vulnerable to water and wind erosion (Iverson et al. 1981; Lovich and Bainbridge 1999). Soil compaction impacts can persist for years, even centuries, after the initial disturbance (Webb and Wilshire 1980; Webb 1982; Froehlich et al. 1985; Prose 1985; Lovich and Bainbridge 1999). Soil compaction inhibits water infiltration and root growth of native plants (Hinckley et al. 1983), contributing to rapid soil erosion and creating conditions favorable to invasive plants (Brooks and Pyke 2002; Brooks and Berry 2006; Jennings 1997a).

Vegetation is also negatively affected through the direct crushing of plants by OHV activities, resulting in reduced vegetative cover (Adams et al. 1982b; Webb 1983; Prose et al. 1987; Bolling and Walker 2000). Webb (1983) found that annual plants remained intact after a single pass by an OHV; however, most plants were destroyed after only 10 passes. The loss of plants and grasses identified as being important to desert tortoises and which have been documented as affected by OHV activities have also been reported by Wilshire (1979), Bury and Luckenbach (1986), and Jennings (1997a).

Fugitive dust created by OHV use can disrupt photosynthetic processes, which in turn have the potential to suppress plant growth (Walker and Everett 1987; Spellerberg and Morrison 1998). Other processes that may be affected by dust include respiration and transpiration (Spellerberg and Morrison 1998). Several morphological factors contributed to plant susceptibility to heavy dust load accumulations, including mat or prostate growth form, lack of a protective stem cortex or leaf cuticle, blocked stomata, cell destruction, and intricate branching or closely spaced leaves that tend to trap dust (Walker and Everett 1987; Spellerberg and Morrison 1998).

Ultimately, disturbance caused by OHV users renders desert tortoise habitat unsuitable for inhabitancy by tortoises, leading to population decline. Bury and Luckenbach (2002) documented patterns of habitat degradation and tortoise population densities on plots affected by OHV use. Plots in non-OHV areas exhibited 1.7 times more live plants, 3.9 times more plant cover, 3.9 times more desert tortoises, and 4.0 times more active tortoise burrows than on plots characterized by heavy OHV use. Berry et al. (1996) reported similar trends of lower tortoise population densities in areas where OHV trails were more prevalent.

OHV use also results in direct mortality to desert tortoises through collisions on the soil surface or by being trapped within burrows collapsed by OHVs (Bury et al. 1977; Berry 1980; Bury 1980; Burge 1983; Luckenbach and Bury 1983; Berry and Nicholson 1984; Bury and Luckenbach 1986; Berry 1992; Brooks 1999a; Lovich and Bainbridge 1999; Grant 2005). OHV-tortoise collisions and destruction of burrows by OHV activities is exacerbated because tortoises spend a significantly greater amount of time (e.g., foraging, burrowing, traveling) in washes, washlets, and on small hills (Jennings 1997a), areas that represent potential, and often preferred, travel routes for OHV users (Bury and Fillmore 1974).

Agricultural Practices

There are numerous private land in-holdings in the western and southern portions of the Superior-Cronese management area in the vicinity of Harvard and Hinkley, as well as adjacent lands outside of the management area, that support agricultural production. Agricultural fields occur over many acres on land in-holdings within the management area; these are areas of lost habitat on lands that should (in theory) be

considered for conservation acquisition, as they are situated within designated Critical Habitat and are surrounded by federal lands. The fragmentation of the landscape due to converted agricultural fields on land in-holdings could curtail desert tortoise dispersal. The proximity of these agricultural fields to desert tortoise habitat within the management area likely provides a considerable threat to tortoise populations, including mortality to tortoises that may wander onto agricultural fields. Agricultural activities such as discing, plowing, mowing, and baling destroy burrows and kill desert tortoises (Stubbs 1989 in Boarman 2002a). Agricultural practices may also contribute to the degradation of adjacent desert habitats, through providing a source for invasive plant populations, fugitive dust, or toxins associated with machinery, pesticides, or fertilizers. Additionally, agricultural activities may draw down the water table, further degrading habitat. Agricultural fields provide subsidies to common ravens and other predators of desert tortoises (Knight et al. 1993; 1999); thus local agricultural activities may have affects on tortoise populations on undeveloped lands within several kilometers of agricultural fields. Agricultural fields are likely important sources of food and water for ravens during times of the year when those resources are generally in low abundance elsewhere, thus resulting in more ravens surviving the summers and winters (Boarman 1993; 2002a).

Mineral Extraction

Mining activities are considerable in the central portion of the Superior-Cronese management area in the vicinity of the Mud Hills and Calico Mountains; additional clusters of mines are present in the eastern and southern parts of the management area. Although there is limited information on the specific impacts of mining activities on desert tortoises, impacts are likely similar to those associated with other development activities, including mortality of desert tortoises, habitat loss, and degradation of adjacent habitat. Mortality may stem from off-road exploratory travel and extraction activities. Desert tortoises can also become trapped within mine shafts an within steep-sided excavations left as a result of mining activity, and trapped or killed by collapsed burrows as a result of blasting (USFWS 1992a). Degradation of adjacent habitat occurs through the introduction of toxins and fugitive dust, and soil disturbance and erosion.

Pollutant deposition from waste rock and tailings can leach into soil and aquatic resources, and toxic particulate metals may become suspended from active mining (Salomons 1994). Chaffee and Berry (2006) reported anomalously high concentrations of arsenic in soil and plant samples collected in or near known arsenic-rich ore mines. These chemicals were detected in 13 plant species known to be consumed by tortoises, including five species favored by tortoises. Arsenic was the only toxin found range-wide for tortoises, and high concentrations of mercury were found in the western Mojave Desert. Abnormally high soil concentrations of several elements, including arsenic, gold, cadmium, mercury, antimony, or tungsten were found up to 15 km from active mining sites, and unusually high plant concentrations of arsenic, antimony, or tungsten were found at least 6 km away from old mines. Detecting toxicants with total chemical analysis does not necessarily indicate a threat to desert tortoises because bioavailable concentrations may not have any toxic effects. However, sick tortoises with elevated levels in the liver of arsenic and mercury were found in previous studies in areas of the western Mojave Desert corresponding to those where these anomalies occurred (Jacobson et al. 1991; Seltzer and Berry 2005).

Military Activities

The Superior-Cronese management area is situated south of and adjacent to the Fort Irwin National Training Center, a major training and maneuver site for military personnel. There are three military-related features within the management area, including the Cuddeback Lake Air Force Gunnery Range, the Superior Valley Gunnery Range, and Manix Trail. The Cuddeback Lake Air Force Gunnery Range is located in the northwest corner of the management area on the China Lake Naval Weapons Center and was originally established in the 1940s as a World War II artillery range by the US Army. In the 1950s

and 1960s, the range was used as both a temporary landing site for U. S. Air Force training and as a practice bombing range. Though the range has been abandoned by the U.S. Air Force, it may still contain unexploded ordnance and toxic chemicals, as it is included in the California Department of Toxic Substances Control cleanup list (DTSC 2007). The Superior Valley Gunnery Range straddles the northern border of the management area boundary near Superior Lake, and is part of the China Lake Naval Weapons Station. Portions of the Superior Valley Gunnery Range, including a simulated airfield and missile batteries, are within the management area, though the majority of this feature is outside of it. Similar to the Cuddeback Lake Air Force Gunnery Range, this site may contain unexploded ordnance and hazardous chemicals and as such, is listed on the California Department of Toxic Substances Control cleanup list (DTSC 2007).The Manix Trail consists of an improved dirt roads that crosses the management area and connects the Manix railhead on the Union Pacific Railroad, adjacent to I-15 in the south, to Fort Irwin in the north. The road is wide and supports the transport of heavy military equipment such as tanks and personnel into and out of Fort Irwin (McIntyre et. al. 2007). McIntyre et. al. (2007) noted that ravens are keenly aware of the bi-monthly movement of some 4000 troops along the Manix Trail, and are known to follow soldiers and steal food rations. The attraction of ravens likely increases the potential for predation on juvenile desert tortoises in the vicinity. The regular movement of vehicular traffic along the road may also increase the potential for vehicle strikes of desert tortoise.

Litter and Illegal Dumping

Data regarding the distribution of illegal dump sites and other litter sources within the Superior-Cronese management area is unavailable, though dumps are likely located in the vicinity of urbanized areas, particularly along the southern border. Illegal dumping of household trash, construction debris, and hazardous waste is commonplace and ubiquitous in the desert, particularly near urbanized areas and along roads, including access roads to utilities, landfills, and mines.

Tortoises may become entangled in trash such as string and rubber bands, and consume pieces of glass, foil, and balloons (Burge 1989; Walde et al. 2007), possibly leading to impaction and death. Deposition of trash into desert environments contributes to habitat degradation. Additionally, trash dumps attract and subsidize ravens and coyotes. Illegal dumping sites have been documented in California deserts to contain hazardous wastes (Boarman 2002a), contributing to the introduction of toxins and pollutants into desert environments. Dump sites likely increases exposure of tortoises to toxic substances and potentially increased susceptibility to disease; however, this threat is likely a localized issue (USFWS 2011).

Toxin and Pollutant Deposition

Toxins and pollutants originate from a variety of human developments and activities, including urban developments, roads, OHV use, mineral extraction, and illegal dumping. Information pertaining to the distribution of illegal toxin dump sites and other toxin and pollutant sources within the Superior-Cronese management area is generally unavailable. However, toxins are most often associated with mines (both active and closed) and illegal dumpsites, which are often located along roads and trails adjacent to urbanized areas. Roads and other areas with frequent vehicle traffic are another source of toxins.

Tortoises likely accumulate toxins in their tissues through the ingestion of plants containing heavy metals and other pollutants. Desert tortoise food plants accumulate heavy metals through uptake by their fibrous root systems (Avery 1998). Elevated levels of metals have been found in desert tortoise tissue (Homer et al. 1998; Jacobson et al. 1991; Seltzer and Berry 2005), including the tissues of ill, dying, and recently dead tortoises (Jacobson et al. 1991); however, the source of these toxins was uncertain. Chaffee and Berry (2006) collected soil, stream sediment, and plant samples from a desert tortoise study area bisected by a paved road and found that lead levels were elevated, albeit weakly, at a distance of 22 meters from the pavement edge, a factor likely attributed to vehicle exhaust. Additionally, Chaffee et al. (1998) and Chaffee and Berry (1999) evaluated various food plants and soils in desert tortoise habitat near mines,

military training areas, and railroads and found elevated concentrations of cadmium, potassium, and zinc in plants.

Collection, Poaching, and Vandalism by Humans

It is difficult to know when and where the illicit activity of desert tortoise collection and poaching occurs, but clues gleaned from various sources indicate that it likely occurs within the Superior-Cronese management area. The California Turtle and Tortoise Club operates an adoption program for desert tortoises, and reported that between 600 and 950 desert tortoises entered the adoption program between 1998 and 2008. The data indicate high numbers of desert tortoise rescues in the Central and Southern California areas, but do not indicate where the animals originated; i.e., whether they were taken from the wild or were bred in captivity. Though certainly a good portion of the tortoises entering the adoption program was hatchlings originating from backyard breeding efforts, many were likely wild-collected adults. Collection or poaching of tortoises by humans likely occurs along roads, legal and illegal OHV trails, and access roads associated with utility developments, mines, and landfills. Collection and poaching activities is likely more substantial in the vicinity of urbanized areas. Evidence for vandalism is more apparent than collecting or poaching, and available data indicate that it is a rare activity within the management area.

Desert tortoises may have been collected commercially for pets as early as 1883, when the Southern Pacific Railroad became the first transcontinental railway constructed across the Sonora and Mojave Deserts. Luckenbach (1982) reported that desert tortoises were collected by mestizo railway construction laborers and transported to stations to be sold or given away as promotional items to European American tourists from the east. From the 1930s through 1960s desert tortoises were commonly collected by mestizo children from desert communities along Routes 66 and 95 to sell to European American tourists as pets (Luckenbach 1982). Tortoises were also collected for scientific purposes (Berry and Nicholson 1984), but likely in smaller numbers. Extensive collection of desert tortoises for use as pets in the 1950s and 1960s was likely an important contributor to population declines, as thousands of desert tortoises were removed from the wild and brought into captivity during this period. Though tortoise populations were protected from harvest from each state in their range by 1961, the collection of tortoises as pets continued (Berry and Nicholson 1984). The work of Grandmaison and Hoffman (2010) and Grandmaison and Frary (2012) indicates that collection of wild tortoises as pets by motorists and recreationists visiting desert areas continues to be a fairly common and ongoing problem. Grandmaison and Frary (2012) reported that 7.4% of motorists attempted to illegally collect tortoises positioned on roads in a study at 50 sites involving 561 human-tortoise interactions, and concluded that a the number of adult tortoises illegally collected in this manner could have a greater effect on tortoise population viability than other forms of mortality.

Poaching is the taking of tortoises by humans for use as food or medicinal uses (Berry et al. 1996). Poaching has been attributed to cultural preferences (Berry et al. 1996; Schneider and Everson 1989) and appears to be rarer than vandalism and collection. Occurrences are mentioned in agency reports (USFWS 1994a, 2008), reported in desert tortoise conservation group newsletters (see http://www.tortoise-tracks.org/newsletter/ttsummer2008.pdf and http://www.tortoise-tracks.org/newsletter/ttfall96.html), and reported by various witnesses in the field (Boarman 2002a). Berry et al. (1996) used law enforcement records, visual observations of suspected poachers, and signs of excavated tortoise burrows to determine the extent of collection within the western Mojave Desert. They found signs of humans having excavated 7.7% of the burrows on study plots in the area (Berry et al. 1996). They deduced that poaching or collection may account for severe population declines in areas characterized by a lack of carcasses to account for the decline, and attributed local tortoise population declines to poaching by Cambodian nationals that had recently moved into the area.

Vandalism is the illegal, deliberate harm or killing of desert tortoises, or damaging of their burrows. It includes deliberately shooting tortoises (Berry 1986b; Berry et al. 1986); turning over, driving over, burning, and decapitating tortoises (Berry and Nicholson 1984); and deliberate crushing or excavation of burrows. Vandalism has been identified in isolated events described by personal accounts from law enforcement, field researchers, and other individuals (Berry 1986b; Boarman 2002a), and in the case of gunshots, has been quantified in Berry (1986b) and Berry et al. (2006). Berry (1986b) found 14.3% of 635 carcasses recorded on study plots in the Mojave and Colorado Deserts between 1972 and 1982 that showed evidence of bullet wounds. Western Mojave Desert sites were characterized by the highest incidence of gunshots, where percentages of total carcasses ranged between 14.6% and 28.9%, compared with 0% to 3.1% in the eastern Mojave Desert sites, and 1.8% to 2.8% in the Colorado Desert sites. These results suggest that the incidence of gunshots is higher near more urbanized areas, and in areas with greater vehicular access and more human visitors (Berry 1986b). Approximately 17% of the carcasses collected at one western Mojave Desert study plot showed evidence of gunshot deaths (Berry 1986b). Berry et al. (2006) found signs of poaching, gunshot, or vandalism in the central Mojave Desert that accounted for 1.2% of total tortoise mortality on the Alvord Slope in the Southern Expansion Area of Fort Irwin, and 8.5% on the Goldstone plot in the Western Expansion Area.

Even if tortoises are not collected by humans, being handled by humans may result in decreased survivorship of the handled individual. Desert tortoises may be handled by humans who encounter them while recreating in the desert, while driving along roads, or conducting research activities. Berry and Nicholson (1984) suggested that human handling of tortoises may lead to their injury or death. Handling or restraint of desert tortoises may cause various types of responses by tortoises, including 1) physiological stress, including their ability to withstand high temperatures and voiding the contents of their bladder; 2) disrupting the tortoise so that it withdraws into its shell for a long period that would prevent it from obtaining food, water, or cover; and 3) transmission of diseases by people handling multiple tortoises without sterilizing their hands (see review in Boarman 2002a). Tortoises are regularly handled during scientific research projects (including blood draws, attaching radio transmitters and identification tags, filing of the carapace, and weighing and measuring). Neither the short- or long-term effects of handling tortoises have been experimentally investigated in terms of changes in biochemistry, increased exposure to disease resulting from handling procedures, or changes in tortoise behavior (e.g., thermoregulation, mating, movement) immediately after handling, although Berry et al. (2002) speculated that factors exacerbating the effects of tortoise death by dehydration may have included handling and research manipulation.

Collectively, these sources of take likely contribute to the loss of significant numbers of individuals from desert tortoise populations (Berry 1986b; Berry and Nicholson 1984; Boarman 2002a; Grandmaison and Hoffman 2010; Grandmaison and Frary 2012). Collection of tortoises as pets may not result in the mortality of the individuals collected, but once they are collected, the effect is the same, i.e., their genes have been effectively removed from the wild population.

Translocation of Tortoise Populations

The Fort Irwin Land Expansion project annexed 545 km^2 of federal lands managed by the BLM to the existing 2,598 km^2 base (Public Law 2002). The expansion areas are in three distinct locations bordering Fort Irwin: the Western Expansion Area (WEA), the Southern Expansion Area (SEA), and the Eastern Expansion Area (EEA). More than half of the annexed land is situated within the Superior-Cronese desert tortoise Critical Habitat Unit, and the expansion areas are estimated to support approximately 2,000 desert tortoises (Heaton et al. 2008). One of the mitigation measures included the capture of these tortoises from the expansion areas and translocation to BLM-managed lands within the Superior-Cronese management area (USFWS 2004). In April 2008, and more than 600 tortoises were moved from the SEA to nearby translocation sites in the management area. The WEA translocation effort, which will involve translocating an estimated 1,000 tortoises, will occur in the future (Esque et al. 2005; Heaton et al. 2008).

The tortoises located in the EEA will not be translocated and instead will remain within the active range. Translocated tortoises face challenges of navigating in a new environment, which places them at risk of death due to dehydration or predation. Additionally, translocation of desert tortoise populations may cause elevated stress hormone levels in translocated individuals; disruption of social behavior patterns and social structure dynamics; and genetic mixing (Bertolero et al. 2007; Field et al. 2007; Rittenhouse et al. 2007; Teixeira et al. 2007).

Desert tortoises occupy home ranges, and generally ‘know’ where to find food, water, mineral, shelter, and shade resources, and mates within them (Marlow and Tollestrup 1982; Berry 1986c; O’Connor et al. 1994). Tortoises that are translocated from their home ranges are challenged with finding food resources, retreat sites, and mates in a foreign landscape. Often, the initial response of translocated tortoises is to reject the new landscape and return to its original home range. Additionally, a significant portion of translocated tortoises also typically exhibits significantly increased movements in their new environments, a behavior that eventually decreases as the tortoises become more familiar with the translocation site over time (Nussear 2004; Field et al. 2007). The increased movements and great distances moved by translocated tortoises expose them to a variety of risks, including heat exposure, predation, and collection/poaching by humans. Desert tortoises that were translocated from the Fort Irwin SEA in 2008 suffered high mortality rates during the following two years. Over the first year following translocations, 25% of tortoises had died; by the end of the second year, 44% of the translocated sample died (Gowan and Berry 2010). The majority of deaths were caused by predation by coyotes, which was likely a function of the drought conditions at the time of the translocation, rather than the translocation itself. The mortality rates of the translocated individuals were determined to be similar to the mortality rates exhibited by resident tortoises at release sites, as well as other portions of the project vicinity (Esque et al. 2009).

Translocation has social and behavioral consequences for both translocated and resident tortoise populations. Tortoises have an elaborate social structure mediated by relatedness and dominance hierarchies (Berry 1986a). Long-term studies of the social structure of a desert tortoise population on Fort Irwin indicates a hierarchy based on a tortoises’ size, past injuries, and size and shape of the gular horn. This hierarchy governs the shape and position of home ranges among both alpha and beta males, as well as between females (Berry et al. 2005; Berry et al. 2007). For translocated populations, this social structure is likely completely dissolved. Among resident populations, the introduction and integration of new adults likely increases antagonistic behaviors through competition for resources and mates. This disruption of the social structure of both translocated and resident populations should be considered a significant threat.

3.2.3 Environmental and Biological Threats

Subsidized Predators

Subsidized predators are predatory species whose survival and population growth are enhanced by the presence of anthropogenic sources of food, water, or other limiting resources (Boarman 1993). As human populations in desert areas have grown and human use of the desert has intensified in recent times, subsidized predators have emerged as a major threat to desert tortoise populations. Two natural desert tortoise predators whose populations have increased in size due to human subsidies are the common raven (*Corvus corax*) and the coyote (*Canis latrans*). A third subsidized species, the feral dog (*Canis familiaris*), has become an important desert tortoise predator as human presence has increased in desert areas. All three species are present within the Superior-Cronese management area, and appear to be more common in the vicinity of human subsidies. Heaton (2007) reported moderate densities of ravens within the southwest portion of the Superior-Cronese management area, along the sampled stretches of Interstate 15 and Interstate 40. At a study of the Fort Irwin relocation sites within the Superior-Cronese

management area, raven densities were found to be highest in three different areas, all of which were anthropogenic linear corridors: Interstate 15, a transmission right-of-way, and Manix Road, which leads into Fort Irwin (McIntyre et al. 2007).

Evidence strongly suggests that raven populations have swelled in recent decades due to human subsidies, and that predation on young desert tortoises by this species has increased as well. Boarman and Berry (1995) reported a 10-fold increase in the number of common ravens in the Mojave Desert between 1968 and 1992. Breeding Bird Surveys performed by the USFWS from 1968 to 1988 yielded a 1,528% increase in raven numbers in the Mojave Desert (USFWS 1994b). Ravens target neonate and juvenile tortoises whose shells have not yet ossified and hardened (Berry 1985; Nagy et al. 2011). Berry (1985) reported seeing juvenile tortoise remains beneath five of twenty raven nests, and reported that for 279 carcasses that could be attributed to raven predation, all of the carcasses were juveniles less than 110 mm in length. Breeding ravens are particularly effective predators of juvenile tortoises. Woodman and Juarez (1988) collected 250 tortoise remains from a nest and associated perch site in the western Mojave Desert, and determined that ravens accounted for 97% of juvenile tortoise deaths at the study site. Campbell (1983) attributed 97% of juvenile tortoise shells at the base of fence posts along a 30.5-mile stretch of fencing to raven predation. Berry et al. (1986) reported ravens as being responsible for 3% to 31.8% of mortality among desert tortoises on the Fremont Peak (3%, two individuals), Kramer Hills (31.8%, seven individuals), Chemehuevi Wash (11%, two individuals) and Chuckwalla Bench (25.5%, 13 individuals) study plots. The long-term implications of elevated predation of desert tortoises by common ravens are not completely understood. The targeted predation of juvenile tortoises no doubt has serious implications for recruitment of juvenile tortoises (Berry 1985; Boarman 1993, 2002b, 2003).

There is no evidence to indicate that coyote populations have increased in response to human subsidies, though there is evidence of their use of these subsidies. Specifically, coyotes are known to frequent landfills (Boarman et al. 2006), and they likely acquire anthropogenic food and water subsidies at the urban-wildland interface. Feral dogs appear to be a significant predator of desert tortoises in the vicinity of anthropogenic subsidies. Feral dog predation has been documented on study plots as early as the 1970s (USFWS 1994b). At one study plot in the south-central Mojave Desert, 80% of the tortoises exhibited signs of dog attack (USFWS 1994b). The Desert Tortoise Recovery Plan (USFWS 1994b) cites several anecdotal examples of feral dogs (either singly or in packs) attacking desert tortoises, including digging up tortoise burrows, harassing individual tortoises, and gnawing on tortoise scutes and bones. Demmon and Berry (2005) reported that evidence of dog attacks on desert tortoises were significantly more common within 3 km of urban developments than in more remote portions of the desert.

Disease

Disease occurrence and causation within the western Mojave Desert is generally far better understood than for other portions of the region. Similarly, the link between disease occurrence and population decline is stronger in this area. For example, tortoise populations on study plots at the Desert Tortoise Natural Area (DTNA) experienced a 76% decline in the tortoise population, including a 90% decline in adults, from 1979 to 1992; this decline was specifically attributed to the presence of URTD (Berry 1997). Peterson (1994) later found that desert tortoises at the DTNA experienced another mortality event, primarily as a result of coyote predation, but alluded to the fact that disease could not be discounted since symptomatic tortoises had been identified previously on that site. Berry et al. (2006) found that the presence of infectious disease in tortoises was negatively correlated with distances from human developments on Fort Irwin and paved roads. Wildlife diseases typically emerge from anthropogenic sources that produce environmental change, such as agriculture, the introduction of invasive species, and human and domestic animal encroachment into wildlife habitats (Daszak et al. 2001; Vitousek et al. 1997). There appears to be a link between invasive plants, toxins, and the incidence of disease. Jacobson et al. (1991) studied URTD and found high concentrations of mercury and iron in the livers of ill tortoises. He hypothesized that tortoises may become ill due to nutritional deficiency from habitat

degradation and reduced forage quality in the Mojave, which led to further research on the role of toxins in forage plants and whether they affect tortoise nutrition. Non-native grasses such as *Schismus* spp. may contain higher levels of metals compared with natives (Avery 1998; Jennings 1997b). Jennings (1997b) concluded that toxicants, nutritional deficiencies, or nutritional deficiencies induced by toxicants are the most likely cause of disease in desert tortoise and that invasive plants may be a pathway for toxicants. Boarman (2002a) warns that a wide range of variables can influence die-off events that are interpreted as disease epidemics, including drought, lack of food sources, predation, and anthropogenic stressors. Furthermore, these other stressors may actually be causing the disease outbreaks. Therefore, while the potential for disease to be a threat to desert tortoise populations certainly exists, there appears a wide variety of factors that confounds determining the cause and level of severity of the threat.

Invasive Plants

Non-native, invasive plant species probably first arrived in the Mojave Desert with settlers during the late 1800s and early 1900s (Jennings 1997b), and following more than a century of livestock grazing and other anthropogenic sources of soil disturbance and seed dispersal have spread across the entire region. Though the diversity of non-native plants introduced into the Mojave Desert ecosystem is low, the percentage of non-native plant biomass is extremely high (Brooks and Berry 1999; 2006). The invasive species of primary concern include: 1) Mediterranean grass (*Schismus barbaratus*); 2) cheatgrass (*Bromus tectorum*), 3) red brome (*Bromus madritensis* subsp. *rubens*); 4) red stemmed filaree (*Erodium cicutarium*); and 5) Sahara mustard (*Brassica tournefortii*). The spread of these non-native species degrades desert tortoise habitat through changing the composition and character of desert scrub vegetation communities, out-competing and replacing native forage species, and altering the cycles, frequency, and intensity of wildfires.

The spread of invasive species is facilitated by paved and dirt roads; human developments and urbanization; anthropogenic water sources; and disturbances caused by human activities, such as mining, recreation (i.e., OHV use), agricultural activities, military activities, and livestock grazing. Invasive annual plants have come to comprise a significant portion of the plant biomass of the Mojave and Colorado Deserts. In one study, invasive plants comprised just 6% to 27% of the Mojave Desert floral diversity but 66% to 91% of the biomass (Brooks and Berry 2006). This dominance of invasive annual species is accompanied by a reduction in native annual species.

Invasive annual species out-compete native annuals, changing the composition and availability of forage plants available to local desert tortoise populations (Brooks 1999b, 2000; Brooks and Berry 1999). Some invasive grasses, including red brome, cheatgrass, and Mediterranean grass, out-compete native species for water (Brooks and Pyke 2001). Mediterranean grass is more successful at water uptake because of a filamentous root structure that spreads easily through the soil and more effectively absorbs water than the typical tap root systems of native species (Boarman 2002a). Certain invasive species (*Bromus* spp., Mediterranean grass, and red stemmed filaree) germinate earlier and their established seedlings can inhibit the growth of native seedlings (Brooks and Esque 2002). Established red brome, Mediterranean grass, and red stemmed filaree more effectively use nitrogen in soils causing reduced native seedling biomass and inhibiting seed germination (Brooks and Pyke 2001). In addition, the accumulation of plant litter from invasive species can impede germination of native plants by shading the soil, reducing water infiltration, and preventing the seeds of native plants from reaching the soil (Brooks 2000; Brooks and Berry 1999; Brooks and Esque 2002).

The most important detriment of invasive annual species is their effect on desert tortoise nutrition. When nutritional, native forbs are replaced by invasive plants, tortoises resort to eating the lower quality invasive species. Desert tortoises have been observed eating Mediterranean grass, red stemmed filaree, and red brome (Nagy and Medica 1986; Jennings 1997a). Desert tortoises prefer native plants over invasive species (Jennings 1997a, but see Avery 1998), but resort to eating non-native annuals in the

absence or scarcity of natives. For example, tortoises consumed red stemmed filaree and red brome on the Beaver Dam Slope in the absence of bush muhly, a native perennial bunchgrass and preferred forage species whose populations had been decimated by grazing livestock (Coombs 1979). Non-native annual species are nutrient (specifically nitrogen and phosphorus) deficient (Avery 1998; Jennings 1997b). Furthermore, desert tortoises select native plants that provide a high nitrogen to potassium (N:K) ratio, which may be difficult to attain with non-native plants (Oftedal and Allen 1996; Oftedal 2002; Oftedal et al. 2002). Mediterranean grass has been shown to deplete nitrogen, phosphorus and water, and cause weight loss in tortoises (Avery 1998; Nagy et al. 1998; Hazard et al. 2010).

The proportion of invasive plants in the diet of desert tortoises appears to vary according to local conditions. Jennings (1993) determined, through direct observation of bites taken by foraging tortoises, that invasive species comprised only 4.65% of bites (3.93% red stemmed filaree, 0.69% Mediterranean grass, and 0.03% *Bromus* spp.). Coombs (1979) reported that red brome and red stemmed filaree formed dominant portions of desert tortoise diets, collectively comprising nearly 30% of the bites taken by tortoises. Avery (1998) determined that tortoises in un-grazed areas predominantly selected desert damdelion (*Malacothrix glabrata*), a native forb, whereas tortoises in grazed areas selected mainly Mediterranean grass.

Invasive species have altered the fire cycle, increasing both the frequency and intensity of wildfires in the desert environment (Brooks et al. 2006). The large biomass produced by invasive plants increases fuel loads that facilitate hot fires in a desert ecosystem that did not evolve to withstand frequent and intense fires (Berry 1998; Brooks and Berry 2006). The introduction of more frequent and intense fires has further contributed to the conversion of desert scrub communities into non-native communities (Brooks and Esque 2002). In addition, invasive grasses thrive in post-fire landscapes, partially due to increased nutrients in the soil; this leads to recurrent fires (Brooks and Pyke 2001; Brooks and Esque 2002) and further degradation of natural desert conditions.

Wildfire

Between 1990 and 2010, wildfires burned approximately 384 acres of desert habitat within the Superior-Cronese management area; thus wildfire appears to be a relatively minor threat compared to other portions of the Mojave Desert where wildfires are more frequent and severe. However, wildfire should be considered a threat within the Superior-Cronese management area because of the high incidence to alien invasive annual grasses and forbs.

The effects of wildfires on the desert tortoise and their habitat pose a significant threat and notable management challenge in the Mojave Desert (AZGFD 2009; Brooks and Pyke 2001; Brooks and Esque 2002; Brooks et al. 2004; Brooks and Matchett 2006). Because wildfires are not a normal component in the Mojave Desert ecosystem, tortoises are not well adapted to cope with their effects (Brooks and Esque 2002). Fires contribute to desert tortoise mortality and injury by producing lethal heat or low oxygen levels, elevating body temperature, and poisoning and asphyxiation by smoke (Brooks et al. 1999; Esque et al. 1994; Whelan 1995). Because desert tortoises cannot move quickly, their primary method of avoiding the effects of fire is to retreat to an underground cover site (Brooks and Esque 2002). Burrows provide tortoise with some degree of protection from fire and deep cover sites such as caliche caves provide more protection from fire than shallow burrows. Because fire can move across a landscape at high speeds, burrows only provide protection if tortoises are in or near existing burrows at the time fires occur. Early season fires are potentially more threatening than mid- or late-season fires because tortoises are most active above ground and use relatively shallow cover sites during the spring (Esque et al. 2003), and high-intensity fires that occur when tortoises are active or occupying shallow cover sites may be particularly detrimental to tortoise populations (Esque at al. 1994).

Wildfires are also an important contributor to habitat degradation, which can happen very quickly and have short term and long term implications. Because the Mojave Desert is not a fire-adapted ecosystem and few desert plants are adapted to the conditions of fire disturbance, fire immediately alters natural desert communities and recovery of habitat is slow (Esque et al. 2003). In addition, fires burn hotter and farther in desert scrub habitats, reducing the natural mosaic pattern (patchy distribution of plants and open space) typical to these communities (Esque et al. 2003). Fire degrades and fragments desert tortoise habitat by killing perennial shrubs and providing optimal conditions for the introduction of invasive annual plant species. The loss of perennial shrubs may result in an increased occurrence of predation on tortoises due to a loss of protective cover. Furthermore, loss of perennial shrub cover may reduce protection from temperature extremes. The introduction of invasive plant species changes the composition of vegetation communities, forcing tortoises to modify typical diets by incorporating less nutritious non-native plants (Brooks and Esque 2002; Esque et al. 2003). Short-term post-fire effects can include reduced availability of food plants, loss or reduction of available nutrients and trace elements, and change in seasonal availability of food plants (Nagy et al. 1998). The long-term effects include a change in community structure that includes increases in the biomass of non-native annual grasses, little shrub cover, and a reduction in native annual plant biomass (Brooks and Esque 2002). Recurrent fire can convert native desert scrub to non-native annual grasslands (Brown and Minnich 1986; Duck et al. 1997; Esque et al. 2003), which are prone to additional recurrent fires because non-native annual grass species often increase in dominance after fire (D'Antonio and Vitousek 1992; Jennings 1997b). Landscape-level changes have the potential to reduce the local availability of suitable habitat and may introduce barriers to animal movement, causing fragmentation of habitat, thus reducing the ability of tortoises to find mates and possibly altering population structure over time (NPS 2004).

Invasions by non-native vegetation may change the frequency, intensity, extent, type, or seasonality of fire, and these changes can either result in increased or decreased prevalence of fire on the landscape (Brooks et al. 2004; Brooks and Matchett 2006). Non-native annual grasses alter the fuel structure and fire behavior in the Mojave and Colorado Deserts, making them more susceptible to frequent fires (Brooks and Esque 2002). Abundant fuel loads place desert tortoises at increased risk from fire (Brooks and Esque 2002), a situation that is exacerbated by the introduction of invasive plants. Areas that support invasive annual grasses such as cheatgrass, bromes, and Mediterranean grass are characterized by high abundance and cover of standing dead stems that create a continuous fuel bed, facilitating the spread of fires (Duck et al. 1997; Esque et al. 2003). Because post-fire landscapes provide opportunities for invasion by non-native plants, particularly those plants that increase fuel loads, and because the presence of non-native plants increases the likelihood, intensity and extent of wildfires, a positive feedback loop may develop that ultimately increases the distribution and abundance of non-native invasive plants and wildfire frequency.

4. PREVIOUS DESERT TORTOISE MANAGEMENT PLANS AND THEIR IMPLEMENTATION

The BLM prescribed desert tortoise management recommendations and decisions for the Superior-Cronese management area within various Resource Management Plans (RMPs). The following discussion details their specifics, as well as a history of the implementation of these measures by the BLM in the context of recommendations provided in the 1994 Recovery Plan (USFWS 1994b).

4.1 Resource Management Plans

4.1.1 California Statewide Desert Tortoise Management Policy (1993)

Plan Details

The BLM's California Statewide Desert Tortoise Management Policy (CSDTMP) was intended as supplement to the DTHMPL (1988) and specified how the management actions in the Rangewide Plan would be applied in the state. The same categories (Categories I-III, with I being the highest quality) used in the DTHMPL was applied to desert tortoise habitat areas within California. Seven management goals (MG) were established in CSDTMP that were primarily focused on restoring and maintaining stable populations in Category I and II habitat areas, while also preventing deterioration and promoting restoration of the habitats within the two categories. Impacts to desert tortoises in Category III habitat areas would be minimized through mitigation and land compensation. Proposed habitat loss due to approved projects on any of the categorized habitat areas would be mitigated through land acquisitions that would help consolidate Category I and II habitat areas.

In order to achieve the MGs for the Categories, 40 guidelines (G) with associated implementation strategies and discussion were established. These included the following:

- MG A sought to restore and maintain stable desert tortoise populations with Category I and II habitat areas. Establishing categories based upon criteria from the DTHMPL was the sole Guideline (G 1) set for the goal.

- MG B sought to minimize impacts to tortoises in Category III habitat areas by using humane and low level mitigation measure (G 2), and acquiring Category I or III through exchange or disposal of Category III (G 3).

- MG C sought to reduce non-natural desert tortoise mortality through public education programs (G 4); the return of recently captive tortoises to point of capture (G 5); adoption of domestic tortoises to BLM-approved entities (G 6); reexamination of vehicle routes (G 7); installation of tortoise-proof fences in Category I and II habitat areas along highways, roads, canals, aqueducts, mine shafts, and other manmade pitfalls that are known or expected to have high losses of tortoises(G 8, G 9, G 10, and G 11); competitive OHV event would be restricted to designated areas and no new OHV areas would be established in Category I and II habitat areas, and those established adjacent would need a functional barrier (G 12, G 13, and G 14); enforcement of existing laws, regulations, rules pertaining to the protection of tortoise (G 15); establishment of shooting closures in areas when tortoise are active (G 16); the implementation of raven management plan (G 17); and implementing studies to determine if water guzzlers subsidize canid predation on desert tortoise (G 18).

- MG D sought to prevent deterioration and promote restoration of Category I and II habitat areas through the reevaluation of sheep grazing (G 19); surface disturbance activities would be restricted to operations that cannot be relocated (G 20); mitigation measures required to minimize surface disturbance to soil and vegetation, including rehabilitation and restoration (G 21 and G22); compensation of lands for residual habitat degradation and loss (G 23); the discouragement of facilities and activities that concentrate visitors (G 24); modification of management practices of established tortoise preserves (G 25); no Category I habitat areas would be transferred from public ownership and Category II habitat areas exchanges would only be approved for equivalent or greater areas of Category I and II habitat areas (G 26 and G 27); and public funds would be used to restore and rehabilitate prior adverse impacts (G 28).

- MG E sought to consolidate Category I and II habitat areas through habitat acquisition and as compensation for losses of areas within each category. This was proposed to be accomplished by establishing a standard process for determining compensation (G 29) and using public funds (G 30).

- MG F sought to maintain and increase desert tortoise populations through the translocation of wild tortoise using experimental determines translocations effectiveness (G 31) and by determining unoccupied or depleted habitats within the tortoise's historic range that could be used for the process (G 32).

- MG G sought to establish interagency coordination in order to demonstrate the commitment necessary to maintain viable desert tortoise populations in California. This was proposed to be accomplished by the implementation of habitat management plans or coordinate resource management plans would be prepared (G 33); establishment of Category I and II habitat areas as sensitive areas for consultation with US Fish and Wildlife Service (G 34); and encouraging other agencies to adopt the guidelines in the CSDTMP (G 35).

- MG H sought to develop and implement a monitoring program that would determine the progress of meeting the other MGS efforts in maintaining viable populations of desert tortoise. This was proposed to be accomplished by continuing surveys on four of fifteen trend plots each year (G 36); compilation and examination of the mitigation measures and stipulations that are intended to benefit tortoises (G 37); requiring compliance reports for all projects that require mitigation measures in regards to tortoises (G 38); the establishment of additional research test plots (G39); and the development of a methodology to track desert tortoise habitat acquisition, enhancements, and losses (G 40).

Implementation Success

In October 1992, the State Director signed the CSDTMP, which designated 620,100 acres as Category I habitat areas and 171,200 acres as Category II (BLM lands only). In April 1993, the BLM amended the California Desert Conservation Area Plan to delineate these three categories of desert tortoise habitat on public lands. Many of the guidelines proposed in the CSDTMP were incorporated into the BLM's West Mojave Plan (2006).

4.1.2 California Desert Conservation Area Plan 1980 as Amended (1999)

Plan Details

The California Desert Conservation Area (CDCA) was designated by Congress in 1976 under the Federal Land Policy and Management Act, and includes 25 million acres across the deserts of southern California. Approximately 10 million acres are managed by the BLM. Congress charged the BLM with developing a long-range plan for the management, use, development and protection of the public lands within the conservation area. The BLM originally published the CDCA Plan in 1980; however by 1999 147 amendments had been added to the plan, which prompted the BLM to publish a reprint of the 1980 plan abridged with the amendments (BLM 1999). The CDCA Plan provides general, regional guidance for management of the plan area over at least a 20-year time period. The CDCA Plan is at the top of a hierarchy that provides a framework for subsequent plans for specific resources and uses, and for the development of site-specific programs or project actions in a manner that is responsive to specific land-use requests. The CDCA Plan covers an area containing over 12 million acres of public lands, the majority of which are under BLM management. Several Areas of Critical Environmental Concern were designated within the CDCA Plan. Plan area lands were also designated geographically into four

multiple-use classes based on the sensitivity of resources and kinds of uses for each geographic area: Class C (controlled), Class L (limited use), Class M (moderate use), and Class I (intensive use). Classes C and L were designated in higher quality habitats with limited manmade impacts and deemed as more valuable to the persistence of desert tortoise populations. The plan describes resources and land uses for twelve elements. Some of the guidelines within the elements pertain to the management of desert tortoises and their habitat (Classes C and L) include the following:

- For Class C habitats, motorized-vehicle use is generally not allowed unless provided for in individual wilderness legislation and management plans, or if necessary to serve valid existing rights, and for emergency use.

- New roads may be developed in Class L habitats under right-of-way grants or pursuant to regulations or approved plans of operation.

- New railroads are not allowed in Class C habitats and only allowed in Class L habitats if no other viable alternative is possible.

- All Class C habitats designated as wilderness areas may be withdrawn from mineral entry at some time and following withdrawal, no new mining claims may be located and no new permits, leases, or material sales contracts may be issued subject to deadlines established by Congress.

- New mines would be allowed in Class L habitats if mitigation and reclamation measures are implemented to protect and rehabilitate sensitive scenic, ecological, wildlife vegetative and cultural values.

- Electric generation plants, new transmission facilities, gas, water and telecommunication lines are not allowed in Class C habitats and new licenses or rights- of-way for these purposes are not be granted.

- For Class L habitats, new gas, electric, and water transmission facilities and cables for interstate communication are to be allowed only within designated corridors.

- Allotments classified as ephemeral sheep operations are to be managed under ephemeral authorizations. Authorizations are to be issued after an interdisciplinary team, along with grazing operators involved, makes a field examination of the allotment to determine whether production of 200 pounds per acre of dry weight will be available for turnout, except in highly crucial desert tortoise habitat, where a 350 pounds-per-acre requirement is specified. These restrictions pertain to both sheep and cattle operations.

- For Both Class C and L habitats, fire suppression measures are to be taken in accordance with specific wilderness fire management plans to be followed by the authorized officer, and may include use of motorized vehicles, aircraft, and fire retardant chemicals.

On March 16, 2000, the Center for Biological Diversity, the Sierra Club, and the Public Employees for Environmental Responsibility filed a lawsuit against the BLM, alleging that the Section 7 process of the ESA had been sidestepped during the development of the CDCA Plan and its amendments. This suit led to an agreement whereby the BLM was charged with developing an amendment to the CDCA Plan that included an additional 58 interim measures aimed at special-status species recovery. Those pertaining to desert tortoise populations in the Superior-Cronese management area, as presented in their final form in the Biological Opinion (USFWS 2002) for the action included emergency road closures, closure of areas to shooting, encouragement of camping at previously disturbed sites, elimination of OHV use off of designated routes, burro removal, implementation of grazing prescriptions (Table 21), complete exclusion

of the Pilot Knob allotment until the West Mojave Plan was signed, and development and implementation of road maintenance rules that would minimize entrapment of desert tortoises, as well as applicable terms and conditions and reasonable and prudent measures (USFWS 2002). The BLM consulted with the USFWS in support of amendments to the CDCA Plan, including one for that addressed plans for the Northern and Eastern Mojave Desert and the Northern and Eastern Colorado Desert (USFWS 2005), and one that designated routes in the West Mojave Plan area (USFWS 2003).

Table 4. Grazing prescriptions approved for allotments within the Superior-Cronese Conservation Area for the 2002 Amendment to the CDCA Plan (USFWS 2002)

Allotment	Acres	Acres of Exclusion	Acres of CH	Acreage of Excluded CH	Spring Limits	Fall Limits	Animal-Days Limits
Pilot Knob	64,810	64,810	48,280	48,280	Year-round exclusion	Year-round exclusion	0
Cronese Lakes	65,304	18,000	30,080	18,000	March 1 - June 15	September 7 - November 7	13,383
Harper Dry Lake	26,314	18,954	16,482	16,482	March 1 - June 15	September 7 - November 7	17,033

Implementation Success

Manix Trail

Ft. Irwin initiated Section 7 consultation with the USFWS in 1991 in support of base operations and training activities in desert tortoise habitat on and adjacent to the base. The Biological Opinion (USFWS 1991c) outlined a number of measures, including several for Manix Trail. Specifically, the USFWS required that Manix Trail be demarcated with physical barriers or prominent markings and that tortoises be moved "out of harm's way" before passage of convoys by using a lead vehicle with a trained observer watching the road.

Linear Utility Construction and Maintenance

The BLM initiated Section 7 consultation with the USFWS in 1995 in support of maintenance activities performed by the Southern California Gas Company on natural gas pipelines on BLM-managed lands. In the Biological Opinion, the USFWS required a series of measures that were dependent on the level of disturbance caused by the activity. The measures included worker environmental training, travel on existing roads, removing trash from project sites, prohibitions on pets and guns at project sites, checking under vehicles for tortoises before moving, biological monitor(s) on site who can move tortoises that wander onto the project site, restricting road maintenance activities to between October 15 and March 1 or June 15 through August 1, preconstruction surveys by an approved biologist, removal of tortoises from burrows within project sites by an approved biologist, and flagging of work areas by an approved biologist, among other protective measures (USFWS 1995d; 1996d). Similarly, the BLM consulted with the USFWS in 1999 in support of maintenance activities performed by Pacific Gas & Electric Company on natural gas pipelines on BLM-managed lands. The opinion carried similar measures applied to the Southern California Gas Company opinion (USFWS 2000b).

The BLM consulted with the USFWS in 2000 in support of the installation of the Level 3 fiber optic line within the existing utility corridor that crosses the Superior-Cronese management area. In the Biological Opinion, the USFWS required that the project site be fenced with tortoise-proof fencing, as well as the aforementioned measures for pipeline maintenance (USFWS 2001).

Smaller Actions

The BLM's California Desert District initiated Section 7 consultation with the USFWS in 1992 in support of small mining and exploration operations in the California desert that were cumulatively not to exceed ten acres (USFWS 1992a). The BLM reinitiated consultation in 1994 following designation of Critical Habitat, and the opinion from the USFWS essentially remained unchanged (USFWS 1994e). Similarly, the BLM initiated Section 7 consultation in 1997 in support of small projects that result in small areas (<2 acres) of disturbance to desert tortoise habitat. The Biological Opinion allowed loss of up to 10 acres of desert tortoise Critical Habitat within a recovery unit per year (USFWS 1997c). Covered actions include disturbance of soils, placement of machinery, exclusion of areas from wildlife use, and construction of permanent structures. Cumulatively, the small actions may total up to 80 acres on BLM lands within the Western Mojave Desert Recovery Unit. The Biological Opinion included measures that minimize potential impacts to desert tortoises and their habitat within the project description, as well as measures that describe how the project proponent would compensate for habitat that is permanently lost (USFWS 1997c).

As part of mitigating potential loss of tortoises on a stretch of road leading to a solar electric plant project site, the BLM consulted with the USFWS in support of constructing a tortoise-proof fence and culvert crossings along Harper Lake Road in an area that bordered the Superior-Cronese Critical Habitat Unit (USFWS 1995c).

Road Widening and Maintenance

The Federal Highway Administration conducted Section 7 consultations with the USFWS in support of road construction and maintenance activities. Although these actions were not proposed by the BLM, they affect desert tortoises on BLM lands and are worth mentioning. In particular, the Ft. Irwin Road widening project included installation of tortoise exclusionary fencing on both sides of the road in order to reduce vehicle-tortoise strikes (USFWS 2002b). The road passes over several drainage structures that provide crossing opportunities for tortoises, allowing for dispersal and gene flow. Two other Biological Opinions issued for Federal Highway Administration actions allowed Caltrans to perform road maintenance activities in the vicinity of the Superior-Cronese management area (USFWS 1994f; 2006c).

4.1.3 West Mojave Plan – Record of Decision – Amendment to the California Desert Conservation Area Plan (2006)

Plan Details

The BLM produced the West Mojave Plan (WEMO) as an amendment to the CDCA for public lands and a habitat conservation plan for private lands. The WEMO is a federal land use plan amendment that presents a strategy to conserve and protect desert tortoise, Mohave ground squirrel, and nearly 100 other special-status species and natural communities, and provides a plan for complying with CESA and ESA (BLM et al. 2005). The WEMO contains four goals for desert tortoise conservation:

> **Goal 1:** Protect sufficient habitat to ensure long-term tortoise population viability.
>
> **Goal 2:** Establish an upward or stationary trend in the tortoise population of the West Mojave Recovery Unit for at least 25 years.
>
> **Goal 3:** Ensure genetic connectivity among desert tortoise populations in the West Mojave Recovery Unit, and between this and other recovery units.

Goal 4: Reduce tortoise mortality resulting from interspecific (i.e. raven predation) and intraspecific (i.e. disease) conflicts that likely result from human-induced changes in the ecosystem processes.

The following specific recommendations are contained in the WEMO that pertain to desert tortoise populations and their habitat:

- Designate the Superior-Cronese Critical Habitat Unit (or DWMA) an ACEC, and manage lands therein as Class L (limited use).

- In general, there would be no new paved highways in DWMAs, except an established list of projects. The West Mojave Plan would provide coverage for these projects and the acreage (1,833 acres total) would serve as the CalTrans Allowable Ground Disturbance. Additional proposals for paved roads would not be covered by the WEMO, and would be subject to separate consultations. Proponents wishing to construct new roads or railroads are encouraged to locate them outside of DWMAs and should implement designs and maintenance procedures that are consistent with the existing terms and conditions identified in various pertinent biological opinions.

- Use of earth-moving equipment or vehicle travel off public roads and designated open routes would not be allowed except under a BLM approved Plan of Operations for exploration activities conducted in accordance with the General Mining Law of 1872.

- With the exception of the Barstow Landfill expansion, the planning of which was initiated prior to development of the WEMO, counties and cities would ensure that no new landfills are constructed inside DWMAs or within five miles of them.

- To the degree possible, new utility right-of-ways in BLM-designated, active and contingent corridors would be situated as closely together as practical given engineering specifications, human safety, and other limiting factors. Within existing corridors, areas that are already disturbed will be used rather than undisturbed areas within the two- to three-mile wide corridor.

- The network of motorized vehicle access routes in the West Mojave that was adopted on June 30, 2003 achieved most of the objectives of the CDCA Plan. Modifications were made with the additional public review of the WEMO to better protect rare species and their habitat, connect travel routes among subregions, allow competitive use of routes outside sensitive habitat and curtail conflicts with private property. Deletion of the Barstow to Las Vegas race course from the 2002 Northern and Eastern Mojave Desert Amendment to CDCA left a fragment of this route remaining open in the West Mojave area. The amendment to delete the remaining one third of the race course is primarily an administrative action to achieve consistency in the CDCA. The competitive corridor between the Stoddard Valley and Johnson Valley Open Areas was changed to a non-competitive connector route and realigned to provide conformance with the 1994 Recovery Plan for desert tortoise, which recommended elimination of competitive events within DWMAs.

- The livestock grazing management prescriptions would be implemented for all cattle allotments managed by the BLM in the WEMO plan area that occur in desert tortoise habitat and within the Mohave Ground Squirrel Conservation Area. Grazing use would continue until lessee voluntarily relinquishes all grazing use. New cattle guards would be designed and installed to prevent entrapment of desert tortoises. All existing cattle guards in desert tortoise habitat would be modified within three years of plan adoption to prevent entrapment of desert tortoises. Any hazards to desert tortoises that may be created, such as auger holes and trenches, would be eliminated before the rancher, contractor, or work crew leaves the site.

- Wildland fire management would be allowed in all management areas and fire suppression would be a mix of aerial attack with fire retardant, crews using hand tools to create firebreaks, and mobile attack engines limited to public roads and designated open routes. The use of earth-moving equipment or vehicle travel off public roads and designated open routes would not be allowed, except in critical situations where needed to protect life and property. Post-suppression mitigation should include rehabilitation of firebreaks and other ground disturbances using methods compatible with management goals.

- Within two years of WEMO adoption, the Implementation Team, BLM, county animal control, and other applicable entities would develop a Feral Dog Management Plan. The Feral Dog Management Plan would, among other things, determine control measures and identify an implementation schedule. In order to limit the subsidization of desert tortoise predators landfills would ensure effective cover of waste multiple times each day; erect coyote-proof fencing; render raven-proof all sources of standing water at the landfill, and (iv) keep truck cleaning areas and temporary storage facilities clean and free from standing water and organic wastes (e.g., food material, biosolids, mixed solid waste, and other materials that may be consumed by common ravens and not including "green material" as defined in Section 17852 by the California Integrated Waste Management Board).

- Carcasses of road-killed animals along highways in desert tortoise habitat would be removed to limit their availability to potential predators of tortoises. The population density of ravens and number of birds that may predate on tortoises would be decreased by reducing the availability of water and raven nests. A raven reduction program would be initiated in areas where ravens are identified as preying on tortoises.

Implementation Success

A lawsuit filed in August 2006 by the Center of Biological Diversity et al. led to a decision in federal court to strike down the WEMO on September 28, 2009. The court rejected the BLM's use of a route designation decision making for designating OHV areas and failure to provide adequate explanation for many of the proposed route changes. Though the court's decision concluded that the BLM violated the Federal Land Policy and Management Act and National Environmental Policy Act (NEPA), the court found that a review of the WEMO's impacts on the desert tortoise undertaken by the USFWS complied with the federal Endangered Species Act (ESA).

4.1.4 Fort Irwin Land Expansion

Plan Details

In order to expand the battle-space environment for training Army brigade-sized units, the Department of Defense proposed to expand the boundaries of Fort Irwin into federal lands managed by the BLM. The lands were primarily located in the northern portion of the Superior-Cronese Critical Habitat Unit along the southern border of Ft. Irwin. The Land Expansion proposal included expansion into three areas including the Eastgate Area, the Southern Expansion Area (SEA), and Superior Valley. The Army proposed to expand into these areas in 2005, 2007, and 2010, respectively.

The proposed project was the subject of several Congressional actions and inter-agency coordination efforts involving the BLM and the USFWS. Public Law 106-554, H.R. 5666, Section 323, required the production of several documents in compliance with Congressional requirements, including a Key Elements Report (submitted to Congress on 4 January 2001), which identified the need for expansion and the history of efforts to expand Fort Irwin, identified threatened and endangered species issues, and

elements of the project. The USFWS provided a Preliminary Review of the effects of the proposed expansion on threatened and endangered species on 28 March 2001. Finally, a Proposed Expansion Plan was submitted to Congress on 13 July 2001. This plan combined the findings and recommendations of the prior two reports and set forth a plan to complete the expansion process.

The Army proposed a variety of mitigation measures to reduce, eliminate or offset direct, indirect and cumulative impacts of the proposed Land Expansion including (among other things):

- Creation of off-limits conservation areas for desert tortoise and Lane Mountain milk-vetch on Fort Irwin;
- Translocation of desert tortoises from expansion areas to BLM lands outside of the training area;
- Purchase of private mitigation lands within desert tortoise critical habitat, as identified in the Biological Opinion from USFWS;
- Purchase and voluntary retirement of cattle grazing allotments within desert tortoise habitat in the west Mojave Desert;
- Contribution towards the BLM West Mojave Plan route closures;
- Use of existing roads in all areas possible.

In 2001, the Omnibus Consolidated Appropriations Act of 2001 (Public Law 106-554) was enacted, which transferred approximately 118,000 acres of BLM-managed federal land to the Army. A total of $75 million was authorized under the law for conservation of desert tortoise and other listed species, based on the analysis of potential impacts of the proposed land expansion and outcome of the Section 7 consultation with the USFWS. The funds were appropriated to implement the following mitigation measures (among others), as identified in the Key Elements Report:

- To the extent practicable and consistent with its military needs, the Army would seek to manage appropriate areas of the UTM 90 Area in such a way as to protect the desert tortoise and its habitat.

- The BLM would designate an approximately 500 square kilometer area just south of Fort Irwin as an Area of Critical Environmental Concern (ACEC). Approximately 3100 acres of existing Fort Irwin lands would become part of this ACEC. This area encompasses critical habitat for the desert tortoise and establishes a land bridge between populations of desert tortoise located east and west of the installation. It also assures that Fort Irwin would not be expanded to the south in the future. The BLM would manage this ACEC for the protection and conservation of the desert tortoise and its habitat and for research on the desert tortoise.

- A Working Group, composed of staff from the Army, USFWS, CDFG, and BLM would evaluate proposals for land acquisition and other conservation measures (e.g., research needs and priorities, management practices) to ensure they meet the appropriate criteria and provide for adequate conservation of the species to offset the impacts of the proposed expansion. The USFWS would make the final determination as to whether any specific parcel of land should be acquired or whether any other conservation measure, including research, is appropriate and should be funded with the authorized appropriations. Conservation measures necessary to comply with the ESA may include, but are not limited to: 1) Establishment of ACECs which encompass wildlife management areas in the West Mojave Desert. The ACECs would provide special management attention to protect and prevent irreparable damage to important wildlife resources within areas (see 43 C.F.R. §1601.0-5); 2) establishment of Research Natural Areas (RNA), including the East Alvord Mountain and Paradise Valley RNAs. Establishment of a mechanism

through the West Mojave Plan for designating additional RNAs to support future research as the need arises, which might include, for example, RNAs encompassing areas to which desert tortoises are translocated; headstarting locations; epidemiological research; or urban interface studies; 3) acquisition of non-federal lands within the wildlife management areas in the West Mojave Desert. These areas would be segregated into distinct acquisition polygons, and priorities would be established for acquiring lands within those polygons. Lands would be acquired from willing sellers in areas with the greatest potential for contributing to the conservation and recovery of desert tortoise populations within the Western Mojave Tortoise Recovery Unit. Acquisition of desert tortoise habitat would include criteria such as a) desert tortoise occurrence; b) suitable desert tortoise habitat; c) overlap of desert tortoise habitat with habitat for other sensitive species.

- Construction of barriers, fences, and other structures that are designed primarily to conserve desert tortoise and designated critical habitat.

- Funding of research studies designed to protect and promote conservation of the desert tortoise and other endangered or threatened species and their critical habitats. The Working Group would make recommendations regarding research needs and priorities. The USFWS would make the final determination regarding the research projects that would be funded with the authorized appropriations;

- Other conservation measures that the Working Group may recommend as being necessary and appropriate to protect and promote the conservation of the desert tortoise and other endangered or threatened species and their critical habitats. The USFWS would make the final determination as to whether a conservation measure should be funded with the authorized appropriations. These might include, but would not be limited to: a) designation and implementation of a vehicle access network within the West Mojave wildlife management areas, including restoration of closed routes and signing. Particular consideration would be given to those areas where route designation and closure would best benefit the conservation of the desert tortoise and other special status species; b) establishment of a line distance sampling monitoring program for desert tortoise populations, to be implemented over 30 years throughout the West Mojave wildlife management areas based on the best available scientific information; c) an education program that promotes the conservation and recovery of the desert tortoise and the protection of the West Mojave Desert's wildlife management areas; and d) initial research or analysis to determine impacts of the proposed expansion that may occur outside training areas, such as, but not limited to, the effects of dust and obscurants on the desert tortoise and its habitat.

- Withdrawal of lands identified as necessary for the long-term survival and recovery of the desert tortoise from mining, location, leasing, sale, entry, and other conflicting land uses in order to prevent the loss of the conservation value of the lands by these competing and incompatible uses.

Implementation Success

As of December 2009, the Army implemented a number of the mitigation measures, including:

- Acquisition of 99,170 acres of private land that will ultimately be transitioned to BLM management.

- The entire length of Fort Irwin Road, from I-15 to the boundary of Fort Irwin, has been fenced with tortoise fencing. Additionally, the Army funded installation of 20 miles of desert tortoise fencing along I-15 in an area with a high concentration of tortoises. Also, the entire southern boundary of Fort Irwin (including expansion areas), from its intersection with China Lake in the

west to its intersection with Hwy 127 in the east has been fenced with desert tortoise proof fencing to keep translocated tortoises from returning to Fort Irwin.

- Desert tortoise field research, including: 1) desert tortoise dispersion following translocation; 2) reproductive output; 3) maternity and paternity patterns following translocation; 4) microhabitat and burrow use patterns; 5) relative tortoise densities in varying vegetation community situations; 6) development of a habitat model; 7) examination of epidemiology and spread of disease; and 8) examination of long-term stress in translocated tortoises.

- Funding of route closures.

- Purchase and retirement of 323,526 acres of grazing allotments within designated Critical Habitat, including all grazing allotments within the Superior-Cronese management area.

4.2 BLM Implementation of the 1994 Recovery Plan

The following discussion pertains to the BLM's management of threats within the Superior-Cronese management area within the context of the 1994 Recovery Plan (USFWS 1994b).

4.2.1 Human Developments

Human developments include urbanization within and adjacent to the management area, roads, railroads, utility developments, landfills, and anthropogenic sources of water. These threats, the recommended Recovery Actions for mitigating them, and the BLM's implementation of these actions are discussed below.

Urbanization

Though the USFWS acknowledged that urbanization was a threat to desert tortoise populations, they provided no general measures or Specific Management Actions in the 1994 Recovery Plan. However, the plan includes the following general recommendations that may be applied to management of the urban/wildland interface:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*
>
> *Prohibit uncontrolled dogs out of vehicles*
>
> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Actions provided in Appendix F of the 1994 Recovery Plan do not specifically address urbanization, but may be applied to managing the urban/wildland interface at the Superior-Cronese management area boundary:

> *Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.*
>
> *Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.*

The boundaries of the management area have not been fenced. Signage has been implemented along Fossil Bed Road only.

Roads

The 1994 Recovery Plan identified a number of general measures, as well as one Specific Management Action, that may apply to road management. The following general measures outlined in the plan do not specifically address roads, but may be applied to managing roads within the management area:

> *Prohibit vehicle activity off of designated roads*

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

> *Prohibit uncontrolled dogs out of vehicles*

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA:

> *Construct barrier fencing along Interstate 15, Ft. Irwin Road, Manix Trail, Superior Lake Road, and the northern border of the DWMA to protect desert tortoises from vehicles, collection, and habitat degradation.*

> *Construct highway underpasses along Ft. Irwin Road to allow desert tortoise movement and to facilitate genetic exchange throughout this DWMA.*

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan does not specifically address roads, but may be applied to road management within the Superior-Cronese management area:

> *Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.*

The CSDTMP offers guidelines that include constructing tortoise-proof fences along highways and dirt roads in Category I and II habitats where tortoise-vehicle strikes are known to be common; wildlife crossings under roads should be considered; The BLM designated routes in the original CDCA Plan and its 1999 amendment. They designated routes once again in 2003 following a lawsuit that charged the BLM had bypassed the ESA Section 7 process in designating the 1999 routes. The CDCA contains no specific restrictions on the construction of new roads within the Superior-Cronese management area. No new roads were constructed between 1990 and 2008, though Fort Irwin Road was widened and improved, and Manix Trail was widened and oiled – actions implemented by the Department of Defense.

Wildlife crossings were included in the improvement of Ft. Irwin Road, as well as tortoise-proof fencing. Tortoise-proof fencing was applied to the north side of Interstate 15 between Ft. Irwin Road and Afton Canyon Road. This action was funded and implemented by the Department of Defense as a mitigation measure for the translocation of tortoises in support of the Fort Irwin Land Expansion Project. Superior Lake Road and the northern border of the original DWMA were subsumed within the Fort Irwin Land Expansion Project, and the Department of Defense funded and implemented fencing of the boundary between Ft. Irwin and the Superior-Cronese management area from China Lake to State Route 127. The County of San Bernardino is currently installing tortoise-proof fencing along Harper Lake Road north of US Highway 58. Manix Trail has not been fenced, but the Department of Defense has implemented measures for avoiding take of tortoises following the issuance of a Biological Opinion by the USFWS. The boundaries of the management area have not been fenced.

Railroads

Though the 1994 Recovery Plan does not address managing existing rail alignments, it includes the following general recommendation that may be applied to the management of rail development:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

The CSDTMP offers no guidelines for the management of railroads. The CDCA Plan recommends the following measures pertaining to rail management:

- Class C: No new railroads and trams will be allowed. Existing railroads and trams may be operated and maintained subject to non-impairment of wilderness values.
- Class L: Railroads and trams may be allowed to serve authorized uses if no other viable alternative is possible.
- Classes M and I: Railroads and trams may be allowed.

Utility Development

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of utility development:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan addresses utility development in the Energy Production and Utility Corridors Element. Utility corridors will be managed under this element in a manner that combines rights-of-way for linear utilities, and avoids sensitive resources.

Landfills

The threat of landfills was addressed by the following general measure that was recommended for all DWMAs:

> *Prohibit landfills*

Additionally, the USFWS recommended the immediate modification and control of landfills within the Superior-Cronese DWMA to prevent subsidizing predators of desert tortoises.

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan does not address landfill development. Most of the Superior-Cronese management area is technically open for landfill development (outside of existing ACECs), though once the West Mojave Plan is approved the entire management area will be designated as an ACEC, and landfill development would not likely occur.

Anthropogenic Water Sources

Though anthropogenic water sources were identified as a threat in the 1994 Recovery Plan, the plan did not address the threat of anthropogenic water sources in its general recommendations for management of the DWMAs or in Appendix F.

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan recommends monitoring and limiting water development within several of the ACECs in the management area, but currently there is not plan in place that assesses water development on wildlife resources, including desert tortoise.

4.2.2 Human Activities

OHV trails and OHV use areas, mineral extraction activities, agricultural activities, toxin and pollutant deposition, litter and illegal dumping, and collection and poaching of desert tortoises by humans

Off-highway Vehicle Use

The 1994 Recovery Plan identified a number of general measures, as well as one Specific Management Action, that apply or may apply to OHV management. The following general measure was written specifically for OHV use:

> *Prohibit vehicle activity off of designated roads*

The following general measures outlined in the plan do not specifically address OHV use, but may be applied to OHV and recreation management within the management area:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

> *Prohibit uncontrolled dogs out of vehicles*

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to OHV use specifically, but may be applied to their management:

> *Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.*

> *Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.*

Finally, the USFWS recommended that illegal OHV use be immediately halted within the Superior-Cronese DWMA.

The CSDTMP recommends that vehicle route designations in desert tortoise habitat be reexamined to minimize conflicts with desert tortoises; that competitive events be restricted to existing open play areas; the prohibition of additional open play areas in Category I and II habitats and the fencing of any new open play areas that are adjacent to Category I and II habitats;

In 1994, Congress designated 53,700 acres of Wilderness Areas in the Superior-Cronese management area, where OHV use and other vehicular travel is prohibited.

Thirty closed routes in the western portion of the management area were rehabilitated and restored by 2002 (Redlands Institute 1992).

Agricultural Practices

The 1994 Recovery Plan includes the following general recommendation that pertains to agricultural practices:

> *Prohibit clearing for agriculture*

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. Agricultural practices are prohibited under the CDCA.

Mineral Extraction

The 1994 Recovery Plan identified one general measure and as one Specific Management Action that may be applied to mineral management. The plan provided the following general measure:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. This recommendation does not refer to mineral management specifically, but may be applied to its management:

> *Initiate cleanup of surface toxic chemicals.*

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan limits disturbance of mining activities to less than five acres for areas designated as Class C and L, as well as in ACECs, and requires a plan of operation that considers potential impacts and provides measures to avoid impacts to sensitive resources such as desert tortoises.

Military Activities

The 1994 Recovery Plan identified one general measure and as one Specific Management Action that may be applied to the management of military activities. The plan provided the following general measure:

> *Prohibit habitat-destructive military maneuvers*

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan pertains to the management of military activities within the Superior-Cronese DWMA:

> *Initiate cleanup of surface toxic chemicals and unexploded ordinance.*

The CSDTMP and CDCA Plan do not address the threat of military activities.

Litter and Illegal Dumping

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of litter and illegal dumps, where target shooting is often a common co-occurrence:

> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to litter and illegal dumping specifically, but may be applied to its management:

> *Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.*
>
> *Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.*

In early 2001, the BLM implemented an interim closure of all shooting activities except for hunting and target practice (at printed paper targets) within the Superior-Cronese management area.

Toxin and Pollutant Deposition

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan pertains to the management of toxin and pollutant deposition within the Superior-Cronese DWMA:

> *Initiate cleanup of surface toxic chemicals.*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. This recommendation does not refer to the management of toxin and pollutant deposition specifically, but may be applied to its management:

> *Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.*

The CSDTMP and CDCA Plan do not address the threat of toxins and pollutants.

Collection, Poaching, and Vandalism by Humans

The 1994 Recovery Plan includes two general recommendations and three Specific Management Actions that apply to managing the collection and poaching of tortoises by humans. The plan includes the following general recommendations:

> *Prohibit release of captive or displaced tortoises*
>
> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA pertains specifically to the collection of tortoises:

Establish a drop-off site for unwanted captive desert tortoises at BLM's Barstow Way Station. Develop programs to make unwanted captives available for research and educational purposes.

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to collection and poaching specifically, but may be applied to their management:

Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.

Finally, the USFWS recommended that vandalism and collection of wild desert tortoises and releasing of captive tortoises be immediately halted within the Superior-Cronese DWMA.

The CSDTMP provides guidelines for dealing with captured or captive desert tortoises, including the return of recently captured tortoises to their point of capture, encouraging adoptions of long-term captive or captive raised tortoises, and prohibiting the release of long-term captives. There are no measures that would reduce the take of tortoises through collecting, poaching, or vandalism within the CDCA Plan. The CSDTMP also recommends that shooting be prohibited during the desert tortoise activity season. In early 2001, an interim closure to all shooting except hunting and target practice (at printed paper targets) was implemented within the Superior-Cronese management area.

Translocation of Tortoise Populations

The 1994 Recovery Plan discusses translocation as possible management tool that should be studied further. The plan provides the following general recommendation that may be applied to the management of desert tortoise translocations:

Prohibit collection of biological specimens, except by permit

The CSDTMP stipulates that 1) desert tortoise translocations and reintroductions be conducted under experimental controls until adequate information is available to ensure their success; and 2) desert tortoises will only be translocated to areas containing suitable habitat that supports few or no tortoises. The CDCA Plan does not address the threat of conducting translocations of desert tortoise populations.

4.2.3 Environmental and Biological Threats

Subsidized Predators

The 1994 Recovery Plan identified one general measure and one Specific Management Action that may apply to the management of subsidized predators. The following general recommendation is provided in the plan:

Prohibit uncontrolled dogs out of vehicles

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA:

> *Reduce raven populations in the DWMA to lessen mortality of small desert tortoises to a point where recruitment into the adult cohort can occur at as rapid a rate as possible.*

The CSDTMP recommends that a raven management plan be developed and implemented, as well as studies directed at determining whether water guzzlers subsidize canid predation on desert tortoise. Sporadic removals of common raven nests have been accomplished in recent years, but a consistent, organized approach to raven management has not yet been developed. Acting as lead agency in support of NEPA review, the USFWS released in 2008 a Finding of No Significant Impact and an Environmental Assessment analyzing the effects of implementation of a raven management plan that would include public outreach and education, reducing human subsidies for the common raven, and limited removal of ravens in designated areas. Later in 2008 the Desert Managers Group established the Raven Management Working Group to carry out the preferred alternative outlined in the Environmental Assessment. As a partner in the Desert Managers Group, the BLM participated in this process. The Raven Management Working Group is currently collecting data in support of developing a raven nest database until the raven management plan is developed. The threat of coyote predation has not yet been addressed. Following the drought of 2006-2007, coyotes turned to preying on tortoises when the black jackrabbit population crashed. This issue became problematic for the Department of Defense during the 2007 desert tortoise translocations performed in support of the Fort Irwin Land Expansion Project. Short-term measures (removal of coyotes with a sharp-shooter) were implemented within several of the release plots on BLM lands in late 2007.

Disease

There is there one Specific Management Action in Appendix F of the 1994 Recovery Plan pertaining to the management of disease within the Superior-Cronese DWMA. The USFWS recommended it based upon the best scientific knowledge at the time, though in recent years the threat of disease is better understood and generally considered to be less dire than previously thought. In addition, implementation of this recommendation would restrict gene flow between the management area and the adjacent Fremont-Cramer Critical Habitat Unit, causing more serious harm. For these reasons, the USFWS has likely abandoned it, and the BLM should not consider it:

> *Along the boundary with the Fremont-Kramer DWMA, a double row of desert tortoise barrier fencing may be necessary to prevent the spread of URTD into the Superior-Cronese DWMA.*

The CSDTMP and CDCA Plan do not address the threat of disease.

Invasive Plants

Though invasive plants were identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

The CSDTMP does not address the threat of invasive plants. The Vegetation Element of the CDCA Plan lists among its goals the elimination of harmful plants and maintenance of diversified native plant communities over the proliferation of non-native species. There is no mention of a plan for assessing, controlling, and monitoring for invasive plants, or measures to implement to achieve this goal.

Wildfire

Though fire was identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

The CDCA Plan states that use of fire suppression activities are to be performed per requirements of fire management plans.

5. RECOMMENDED FUTURE MANAGEMENT PRIORITIES

The following recommendations for prioritizing management areas and threats within the Superior-Cronese management area are based upon analyses that were conducted in support of this document. The analyses included: 1) a preliminary analysis of the occurrences, distributions, and severities of threats within the management area, as well as an assessment of historic population trends; 2) development of a habitat model to depict the probability of desert tortoise occurrence within the management area; and 3) development of an individual-based, spatially-explicit population model of the management area to examine the effect of threats on desert tortoise demography. The analyses are detailed in the following appendices and summarized below:

- Appendix A: Preliminary Analyses of Threats and Population Trends
- Appendix B: Development of the Habitat Model
- Appendix C: Development of the Population Model

Preliminary Analyses of Threats and Population Trends: Data collection activities pertaining to the occurrences, distributions, severities, and probabilities of various threats to desert tortoise were initiated in 2008. As well, historic information pertaining to desert tortoise population trends within the management area was compiled. These research activities included: (1) developing a set of maps depicting suitable and occupied desert tortoise habitat within the management area, both at the time of listing and at present, using aerial photography or remote sensing; (2) developing habitat suitability maps using soils, elevation, vegetation communities, and other key habitat variables; (3) using all available desert tortoise location information to further refine habitat suitability in the management area and to determine those portions of the suitable habitat that are currently occupied; (4) characterizing changes in both suitable habitat and desert tortoise population distributions from 1990 to 2008; (5) summarizing changes to relevant land use plans for the management area from 1994 to present; (6) summarizing progress and effectiveness of the implementation of management recommendations for desert tortoise within the current land use plans; (7) assessing the level of law enforcement within the management area between 1994 and 2008; (8) conducting a spatial analysis of threats and their changes between 1994 and the present within the management area; (9) developing a thorough review of threats within the management area; (10) developing a preliminary prioritization of the threats, with rationalization for their ranking; (11) determining how the threats should be characterized for incorporation into the HexSim model; (12) evaluating the status of the Specific Management Actions identified in Appendix F of the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a) for the management area; and (13) recommending which actions identified in the 1994 Desert Tortoise Recovery Plan (if any) should be given priority consideration for implementation by BLM or land managers, based on the results of the threats analysis.

Habitat Modeling: A predictive habitat model was developed using stepwise logistic regression techniques to compare known presence and absence locations for desert tortoises to the known presence and absence of their habitat elements. Tortoise presence within rasterized 30 m resolution grid cells was determined from census surveys of study plots, radio telemetric observations, opportunistic field observations, and previously collected occurrence data. The habitat element dataset included precipitation data, topographic data, biotic data, and geomorphologic data. The habitat model depicted areas of predicted desert tortoise occurrence within the management area, and showed high probability for occurrence in the Grass Valley/Gravel Hills area in the northwestern portion of the management area; the Mud Hills/Calico Mountains area in the central portion; and the Alvord Mountain/Cronese Mountains

area in the eastern portion. The environmental variables that best explained the distribution of desert tortoise observations included: annual precipitation, summer precipitation, winter precipitation, aspect, geology, vegetation community, soil parent material, soil pedogenic setting, and soil caliche potential.

Population Modeling: A population model was developed using HexSim simulation software. The habitat model served as a descriptor of habitat suitability, and allowed for the parameterization of resource availability, population densities, and tortoise movement behaviors. Reproductive rate and movement behavior parameters were determined from existing literature, and survivorship rates were determined from a combination of existing literature and iterative simulations to produce a stable population. Once a stable baseline population was developed, threats scenarios (human presence, subsidized predators, disease, and degraded habitat on land in-holdings) were introduced and population response simulated. These simulations determined the following rank of importance of threats in limiting tortoise populations: 1) human presence; 2) subsidized predators; 3) disease; and 4) degraded habitat on land in-holdings.

5.1 Desert Tortoise Habitat Area Priorities

The habitat model developed in support of this analysis indicates the probability of desert tortoise occurrence based on habitat elements important for the species (Figure 3a; Appendix B). The model generally coincides with USFWS-designated Critical Habitat within the management area (Figure 3b). Few of the areas supporting important desert tortoise habitat are protected by special BLM designations that allow for focused management of desert tortoise populations, including several ACECs (Figure 3c). Areas identified within the habitat model as being high for desert tortoise occurrence probability should receive management priority. Within the management area, three large habitat areas are evident, including the Grass Valley/Gravel Hills area, the Mud Hills/Calico Mountains area, and the Alvord Mountain/Cronese Mountains area. A relatively small habitat area is located in the Iron Mountain vicinity (Figure 3d). Tortoise conservation implementations and land management prescriptions geared toward desert tortoise conservation should be prioritized in these areas. As well, the BLM should ensure that connectivity between tortoise populations inhabiting these areas is maintained. Specific management concerns for each of the areas are discussed below.

5.1.1 Grass Valley/Gravel Hills

The Grass Valley/Gravel Hills desert tortoise habitat area is located in the northwestern portion of the management area (Figure 3d). A significant portion of this habitat area is protected within the Grass Valley Wilderness Area. Portions also fall into the Black Mountain ACEC. Though this habitat area represents one of the more remote portions of the management area, a number of threats affect tortoise populations there. The Cuddleback Lake Air Force Gunnery Range is located in the west-central portion of this area on a large in-holding. Toxins and unexploded ordnance associated with the gunnery range may degrade habitat within and adjacent to the in-holding on which it is situated, including habitat within the Grass Valley Wilderness Area, which could contribute to disease outbreaks within local tortoise populations. The Gravel Hills in the southern portion of the Grass Valley/Gravel Hills desert tortoise habitat area are largely comprised of private land in-holdings These in-holdings could be degraded through urbanized development, conversion to agriculture, or by mineral extraction activities or other land uses that disturb soils and vegetation. OHV recreationists frequent this habitat area, and a proliferation of roads and routes are located among the Gravel Hills. Additionally, there are two landfills and several mineral extraction sites within this habitat area. Management efforts should be directed toward assessing levels of toxins on BLM-managed lands adjacent to the Cuddleback Lake Air Force Gunnery Range and cleaning/restoring those sites, acquiring private land in-holdings in the Gravel Hills,

limiting human access to this habitat area, and establishing additional ACECs or other designation that would protect the lands and prioritize management of the tortoise populations there.

5.1.2 Mud Hills/Calico Mountains

The Mud Hills/Calico Mountains desert tortoise habitat area is located in the central portion of the management area (Figure 3d). A significant expanse of desert tortoise habitat is located here, providing links to tortoise populations to the east and west. The northern boundary is the location of the Fort Irwin SEA, which was cleared of tortoises in 2008, and the southern boundary abuts the community of Lenwood and the city of Barstow; therefore connections to tortoise populations to the north and south are constrained. Small portions of this habitat area are protected within the Rainbow Basin/Owl Canyon, Coolgardie Mesa, and Black Mountain ACECs. The primary threat to tortoise populations in this habitat area is the urbanization within and adjacent to the southern boundary of the management area, and the proliferation of roads and routes throughout this habitat area. An additional area of light urbanization is located on private in-holdings adjacent to Coyote Dry Lake. The urbanized areas contribute to substantial human presence in adjacent desert habitat areas, subsidized predator populations, and stressors that contribute to disease incidence in tortoise populations. The roads and routes provide additional opportunities for human presence, and OHV recreationists frequent this habitat area. The southern portion of this habitat area is the location of utility corridors (energy transmission and buried pipelines), which provides additional opportunities for human access, and perching/nesting structures for common ravens. There is an abundance of mineral extraction sites throughout this habitat area, which has likely contributed to the introduction of toxins into adjacent desert habitats. Another threat is the large number of private land in-holdings within this habitat area. These in-holdings could be degraded through urbanized development, conversion to agriculture, or by mineral extraction activities or other land uses that disturb soils and vegetation. Management efforts should be directed toward limiting the effects of the urban-wildland interface in the vicinity of Barstow, limiting roads and routes, limiting further utility and mineral development, restoring disturbed habitat (including the removal of toxins at mine sites), acquiring private land in-holdings, and establishing additional ACECs or other designation that would protect the lands and prioritize management of the tortoise populations there.

5.1.3 Alvord Mountain/Cronese Mountains

The Alvord Mountain/Cronese Mountains desert tortoise habitat area is located in the eastern portion of the management area (Figure 3d). There are no land designations that protect the desert tortoise population there, but this habitat area represents the most remote portion of the management area. A number of threats affect tortoise populations there, including utility developments, mineral extraction sites, and a proliferation of roads and routes. These threats facilitate human use of the area, introduce toxins into adjacent habitats, and provide perching and nesting structures for ravens. Additionally, private land in-holdings comprise a significant portion of this habitat area. These in-holdings could be degraded through urbanized development, conversion to agriculture, or by mineral extraction activities or other land uses that disturb soils and vegetation. Management efforts should be directed toward limiting human access, limiting further utility and mineral development, restoring disturbed habitat (including the removal of toxins at mine sites), acquiring private land in-holdings, and establishing additional ACECs or other designation that would protect the lands and prioritize management of the tortoise populations there.

5.1.4 Iron Mountain

The desert tortoise habitat model indicates a small area of habitat in the Iron Mountain hills in the southern-most portion of the management area (Figure 3d). This habitat area is small, and its location on the south side of the Mojave River probably prevents linkages to populations in other portions of the

management area. Management efforts should be directed toward determining the occurrence and status of tortoise populations there, and linkages to other tortoise habitats outside of the management area.

5.2 Priority and Management of Threats

Based upon the population modeling effort (presented in Appendix C), the rank of importance of threats to desert tortoise populations is as follows:

1) Human presence
2) Subsidized predators
3) Disease
4) Habitat degradation on land in-holdings

The priority of these threats was developed using a population model, which in turn was developed using information obtained from existing data sources. The HexSim population model allowed for simulating the effects of threats to tortoise populations based upon these data. Though the simulated desert tortoise population responses in the HexSim model cannot be considered a predictor of how populations would actually respond to the threats, simulating each threat separately allowed for an assessment of their relative effects to the simulated population, and a prioritization of management prescriptions based upon the relative effects of the threats. Further data collection may strengthen the model through testing of the hypotheses generated by the model. The following discussion details how the threats affect desert tortoise populations and their habitat within the Superior-Cronese management area, and provides recommendations for managing them.

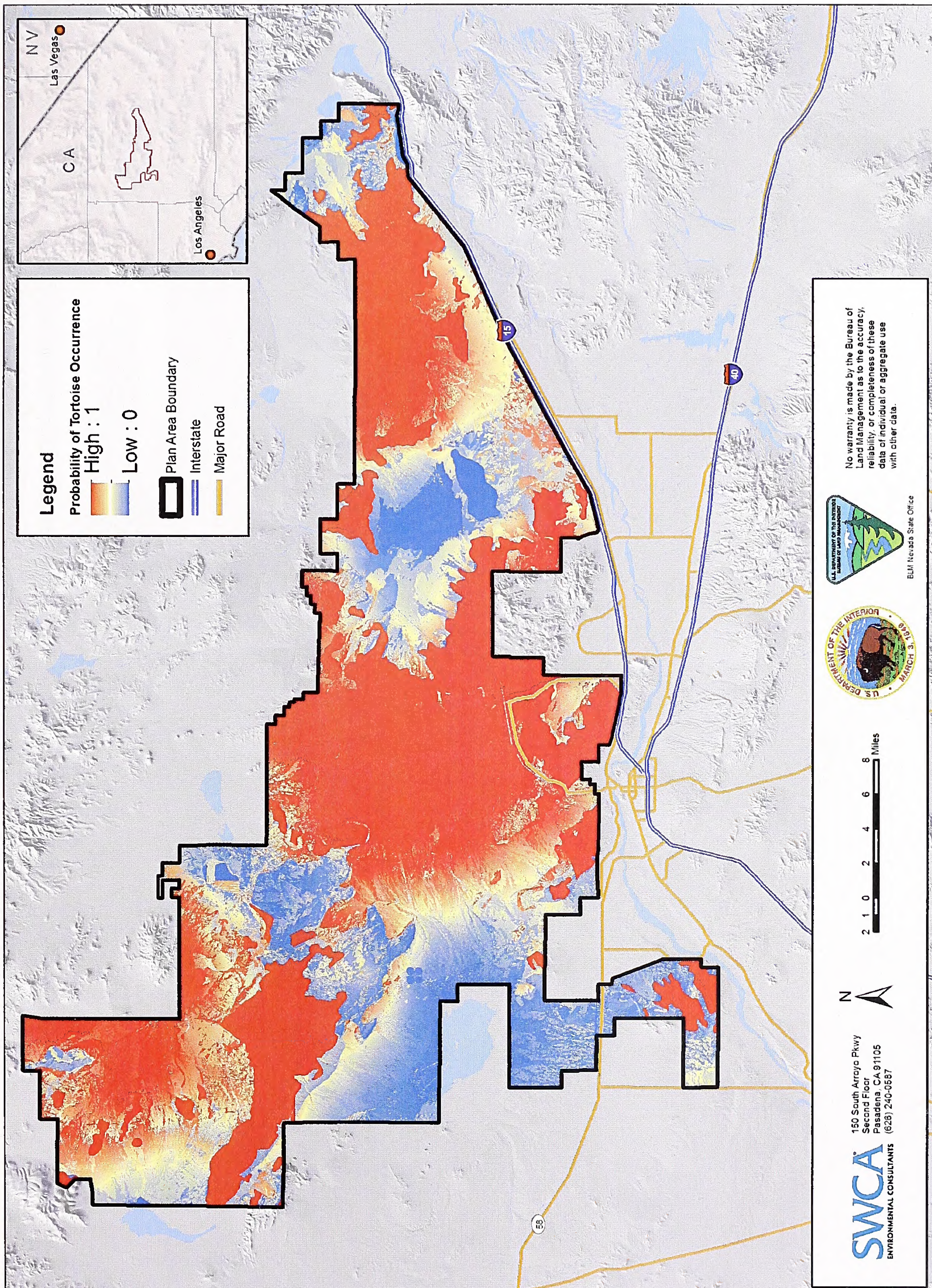

Figure 3a. Desert Tortoise Habitat Model for the Superior-Cronese Management Area.

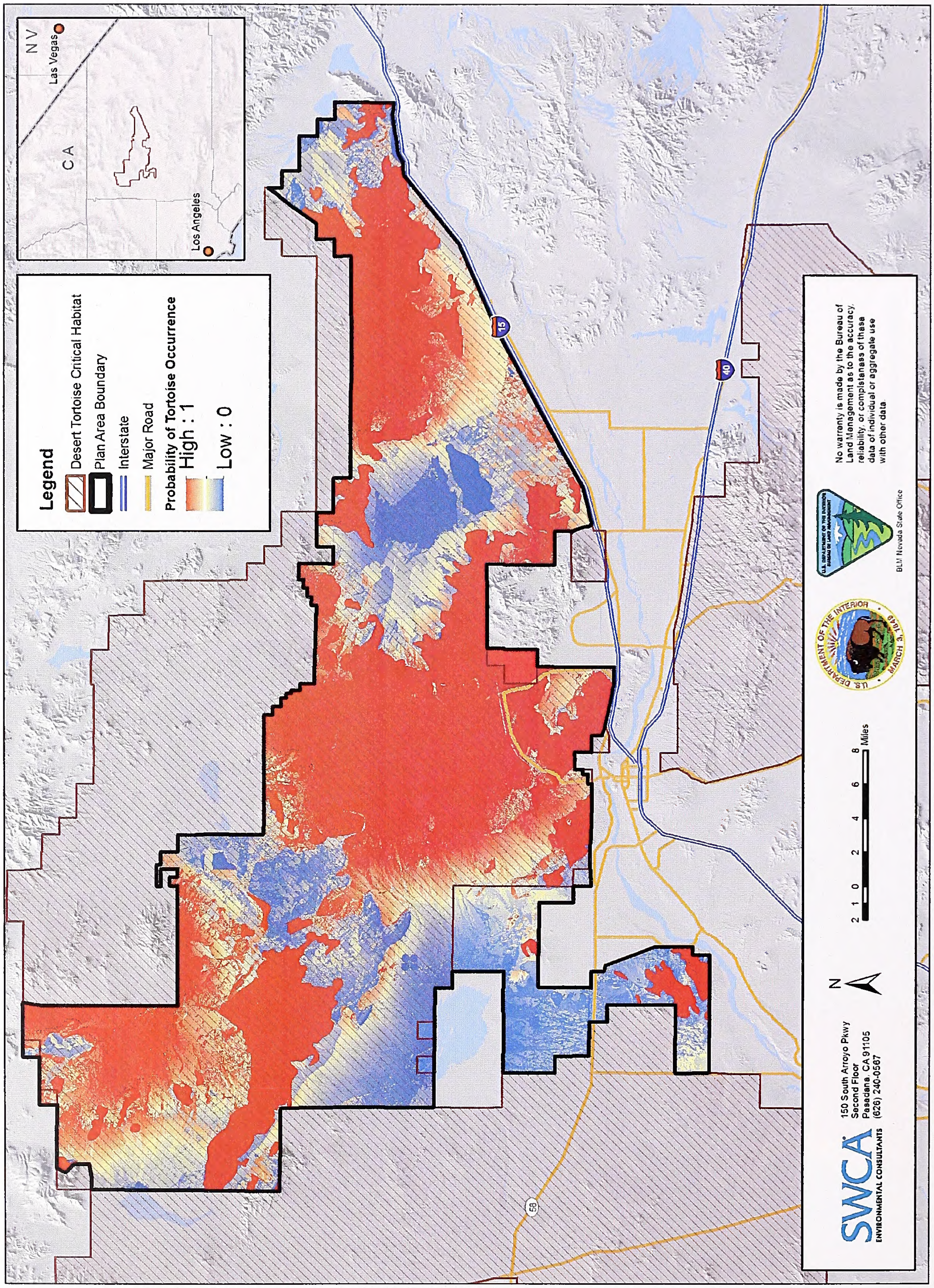

Figure 3b. Superior-Cronese Critical Habitat Unit Overlain on the Habitat Model.

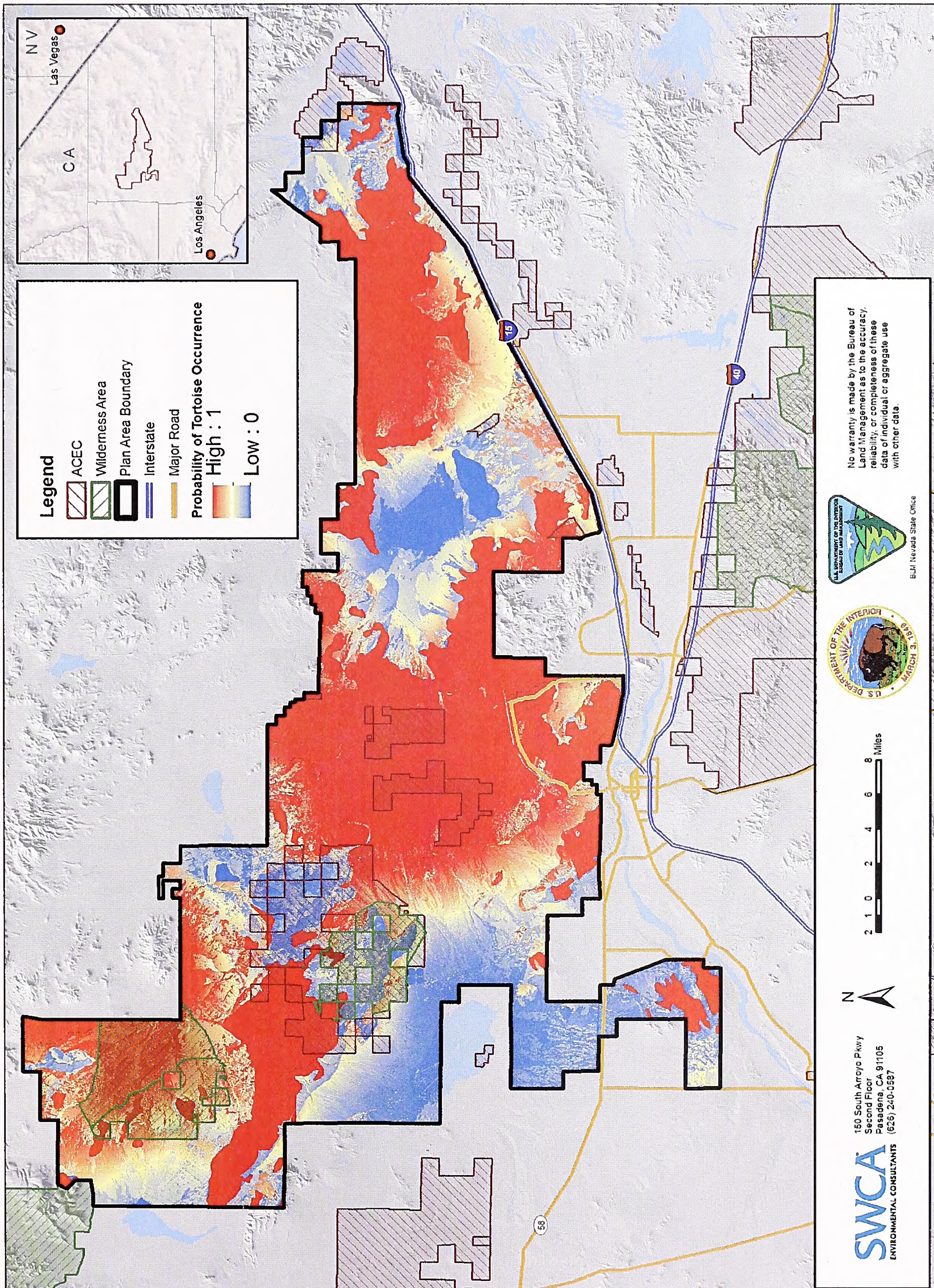

Figure 3c. BLM Management Areas Overlain on the Desert Tortoise Habitat Model.

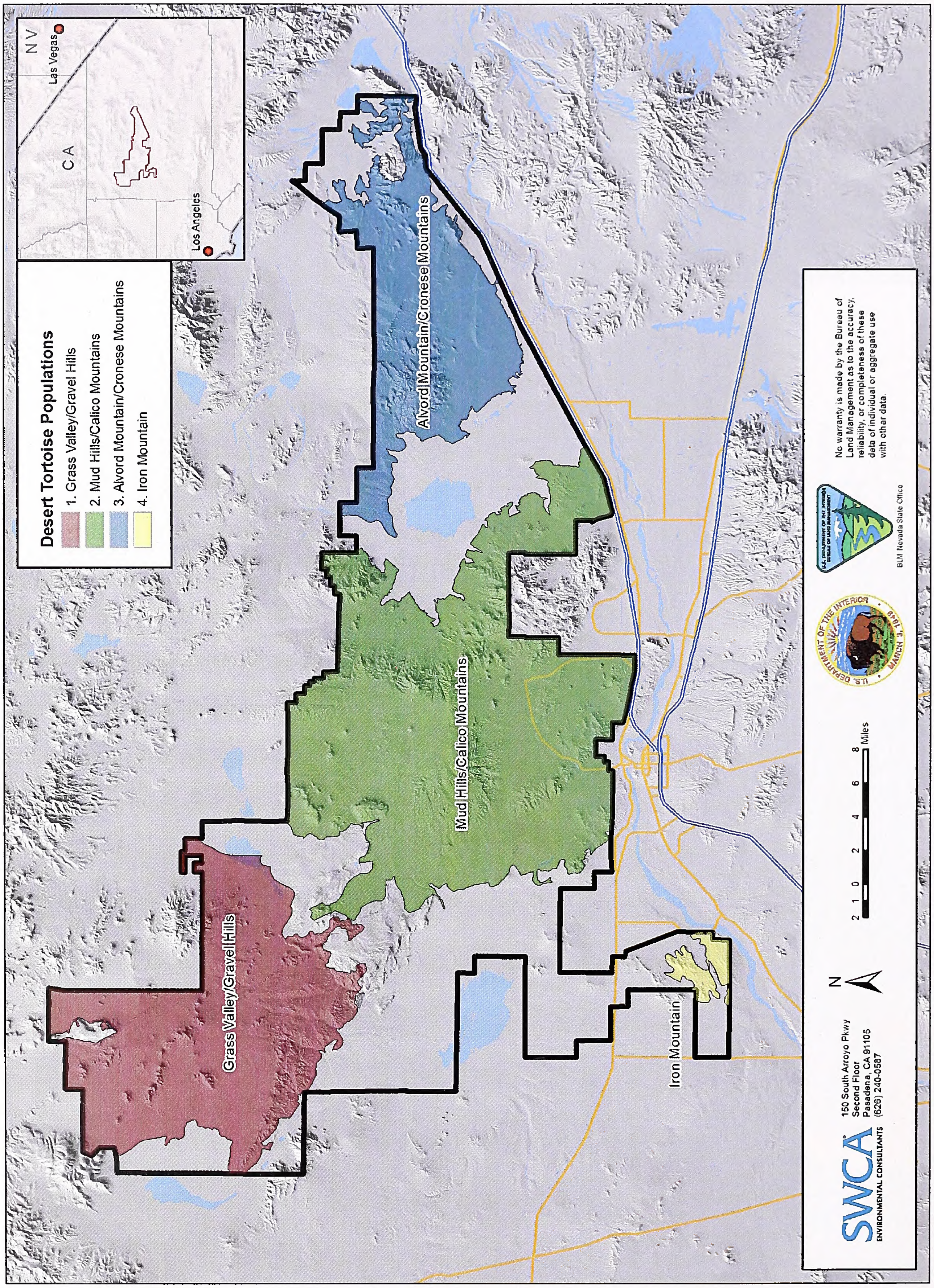

Figure 3d. Desert Tortoise Habitat Areas within the Superior-Cronese Management Area.

5.2.1 Human Presence

Urbanization

Urbanization within and adjacent to the Superior-Cronese management area has affected desert tortoise habitat fairly substantially, and has likely influenced the distribution and density of adjacent desert tortoise populations. The management area contains a substantial amount of land in-holdings, and three areas of these in-holdings include parcels that have been developed. These include ranching developments with numerous homesteads north of Hinkley, agricultural developments with numerous homesteads north of Harvard, and several ranches with homesteads west of Coyote Dry Lake. In addition, urbanization associated with Barstow either abuts or slightly overlaps the management area boundaries at several locations. Tortoise populations in the immediate vicinity of these developed areas have likely been extirpated prior to the listing of the desert tortoise. This may be particularly the case for the developments north of Hinkley, where livestock grazing on adjacent properties was likely intense.

Recommendations

- Implement Recovery Actions 2.3 (establish/continue environmental training programs) and 2.8 (sign and fence boundaries of sensitive or impacted areas) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Environmental education within communities at the urban/wildland interface may be a method of informing the public about the status of the desert tortoise and land designations near their communities. Additional signage should be installed at the urban/wildland interface. Development of an education kiosk or interpretive center should also be considered.

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Roads and routes leading into the management area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the management area.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Surface disturbances at the urban/wildland interface should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

- Implement Recovery Action 2.7 (install and maintain urban or other barriers) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The urban/wildland interface between Hinkley and Yermo should be fenced with tortoise-proof fencing to prevent dispersal of tortoises into the urbanized area along the US Hwy 58 and I-15 corridor.

Roads

Roads are a prominent feature along and within the southern portion of the management area, with the nexus being the community of Barstow. Most of these roads are associated with the "crossroads" character of Barstow, while others connect communities as far west as Hinkley and as far east as Calico/Yermo. Additionally, significant roads that provide the primary access to Ft. Irwin for personnel (Ft. Irwin Road) and equipment (Manix Trail) cross through the management area. Some of the roads, including portions of I-15, Ft. Irwin Road, and Hinkley Road, have been fenced with tortoise-proof fencing. Despite this, roads remain an important feature affecting desert tortoise populations within the management area.

The distribution of roads within and adjacent to the management area have likely resulted in local depressions or depletions of desert tortoise populations. This threat may also by preventing or restricting genetic exchange between populations within and outside of the management area. "Mortality sinks" associated with roads comprise a substantial portion of the management area, and have likely lead to population declines between since listing of the species through tortoise-vehicle strikes and collection of tortoises by humans. Even when tortoise-proof fencing is applied to roadsides to prevent take of tortoises, recent research indicates that population recovery is slow.

<u>Recommendations</u>

- Implement Recovery Action 2.5 (restrict, designate, close, and fence roads) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Road density studies should be performed to determine whether redundancies exist, and to recommend closure of roads that would balance the need for low road density with public access desires. Road closures should prioritize redundancies, particularly adjacent to urbanized areas, roads that service former mineral extraction sites, and roads that were constructed for livestock management purposes to access allotments that are now closed. Road closure efforts should seek to: 1) make access difficult or impossible, 2) restore habitat to natural conditions, and 3) be successfully enforced by BLM patrols. Establishment of new roads in the management area should be avoided. There are opportunities for additional fencing of Interstate 15 west of Ft. Irwin Road and east of Afton Canyon Road, as well as the southern side of Interstate 15 along the entire length of the management area boundaries. Additionally, tortoise-proof fencing should be applied to the Yermo Cutoff from Ghost Town Road to Ft. Irwin Road. This two-lane highway is accessed by a substantial amount of high-speed traffic going to Fort Irwin, including semi-trailer trucks, and the probability for tortoise-vehicle strikes is high. The BLM should develop and implement a fencing plan for these roads. The plan should include a design that directs tortoises to wildlife crossings at the underpasses (or provides them along the Yermo Cutoff), and a recommendation for periodic monitoring of the fences to assess maintenance needs.

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). High-traffic routes should be patrolled regularly to enforce speed limits and check for appropriate uses and activities within the management area.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Closed routes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring closed routes that include monitoring/reporting of restoration efforts.

- Implement Recovery Actions 2.3 (establish/continue environmental training programs) and 2.8 (sign and fence boundaries of sensitive or impacted areas) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Signage should be installed along roads that enter the management area along the southern boundary. Currently signs are positioned only on Fossil Bed Road. Other high-traffic routes should be prioritized for signage. Recreationists could be reminded that they are in Critical Habitat for desert tortoises, perhaps accompanied by interpretive signage. Any additional signage in the management area should be low-statured, no more than 6-ft in height, in order to prevent the signs from being used by ravens for nesting or perching in desert tortoise habitat.

- Implement Recovery Action 2.11 (connect functional habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). This may be implemented through the planning and installation of wildlife crossings at appropriate locations along roads in and adjacent to the management area, particularly Interstate 15.

Railroads

The Burlington Northern Santa Fe railroad crosses through the southern portion of the Superior-Cronese management area. The railroad alignment may affect desert tortoise populations in the southwestern portion of the management area west of Hinkley, as well as populations along the southeastern border of the management area, from Yermo to the west side of Harvard, and from the east side of Harvard to the sharp eastward turn just south of the Afton Canyon Road exit off of Interstate 15. Tortoises attempting to cross the railroad during dispersal movements may become caught between the tracks, causing them to overheat and die or be crushed by trains.

Recommendations

- Implement Recovery Action 2.5 (restrict, designate, close, and fence roads) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The CSDTMP recommended the installation of tortoise-proof fences in Category I and II habitat areas along a number of linear features, including highways, roads, canals, and aqueducts, but neglected rail alignments. This measure should be applied to railroads within the management area. The BLM should develop and implement a fencing plan for the railroad alignment between the outskirts of Hinkley and US Highway 395; between Yermo and the west side of Harvard; and between the east side of Harvard and the sharp eastward turn just south of the Afton Canyon Road exit off of Interstate 15. The plan should include a design that directs tortoises to wildlife crossings at the underpasses located along this portion of the rail alignment, and a recommendation for periodic monitoring of the fence to assess maintenance needs.

- Implement Recovery Action 2.11 (connect functional habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). This may be implemented through the planning and installation of wildlife crossings at appropriate locations along the rail lines.

Utility Development

The most prominent utility features within the management area are electrical transmission lines, gas pipelines, and other subsurface linear utilities such as fiber-optic lines. These features are particularly pronounced in the southern portion of the management area, where several linear utility corridors are situated. Electrical transmission lines provide perching and nesting structures (on towers); in providing these subsidies to the common raven, the presence of the transmission lines within the management area has likely resulted in increased predation pressure on juvenile desert tortoises within several kilometers of the alignments. Activities associated with the construction and maintenance of gas pipelines are known to cause high rates of desert tortoise mortality (Olson 1996).

Recommendations

- Implement Recovery Action 2.1 (conserve intact desert tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). If utility projects that result in ground disturbance are authorized within the management area, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Disturbances caused by the development of utilities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts. Existing utility corridors should be assessed for the presence and abundance of invasive plants, which are a common character of these features. The spread of invasive plants along these corridors should be considered a major threat to habitat quality in adjacent areas occupied by desert tortoises, and efforts should be implemented to reduce or eliminate alien plants from the corridors.

- Plans developed for gas pipeline construction and maintenance activities should include more robust mitigation measures to prevent take of desert tortoise.

Off-highway Vehicle Use

OHV use has become more popular within the management area over the past 20 years, and recreationists from the region utilize trails there. OHV recreationists target an area in the central portion of the management area west of the Calico Mountains in the vicinity of the Mud Hills and extending southwestward toward Rainbow Basin and Owl Canyon. OHV use has also impacted areas within the Coolgardie Mesa ACEC, and washes extending to the southwest of the ACEC. Other portions of the management area likely receive pressure from OHV use, particularly washes extending from designated routes.

Recommendations

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The management area should be patrolled regularly to enforce OHV regulations. Level of patrols should be proportional to the intensity of use by OHV recreationists.

- Implement Recovery Action 2.10 (restrict off-highway vehicle events within desert tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). OHV events should be prohibited within the management area.

- Implement Recovery Action 2.8 (sign and fence boundaries of sensitive or impacted areas) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Sensitive areas that are subject to repeated illegal OHV use should be fenced and posted with signs.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Closed trails and washes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

- Implement Recovery Action 2.3 (establish/continue environmental training programs) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Environmental education within communities in the region may be a method of improving attitudes of illegal OHV recreationists. Interpretive signage may be another method of informing recreationists of the consequences of illegal OHV use.

Mineral Extraction

Mining has been a prevalent land use within the management area, but has likely only been a factor in affecting desert tortoise populations at the local level.

Recommendations

- Implement Recovery Action 2.1 (conserve intact desert tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Surface mining should be prohibited in desert tortoise habitat. For mining projects that result in ground disturbance, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Disturbances caused by mineral extraction activities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts. Additionally, the plans should include provisions for evaluating mines sites for the presence and clean-up of toxins.

Military Activities

Military activities within the management area include: 1) the Cuddleback Lake Air Force Gunnery Range situated on a land in-holding in the northwestern portion of the management area; 2) the Superior Valley Gunnery Range that straddles the northern boundary of the management area; and 3) Manix Trail, which crosses the eastern portion of the management area. The gunnery ranges do not likely contribute to desert tortoise mortality, and habitat degradation within these areas is localized. Manix Trail contributes a relatively larger impact on desert tortoise populations, as tortoise-vehicle strikes have likely occurred, possibly causing local depressions or depletions of desert tortoise populations. Additionally, the oils used to surface the trail may be contributing to the introduction of toxins into adjacent habitat.

<u>Recommendations</u>

- The BLM should coordinate with the Department of Defense to track the implementation of measures to ensure that desert tortoises are not killed by military convoys accessing Fort Irwin along Manix Trail. Reporting should be included in this coordination.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). If discovered, areas containing unexploded ordnance should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of clean-up and restoration efforts.

Litter and Illegal Dumping

Litter and illegal dumping is likely limited to areas along roads and trails leading into the management area from urbanized areas, as well as at camp sites frequented by recreationists.

<u>Recommendations</u>

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Roads and routes leading into the management area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the management area, as well as locate new dump sites. Laws pertaining to dumping, camping, and other illegal activities in desert tortoise habitat should be enforced.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). If discovered, illegal dump sites should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

- Implement Recovery Actions 2.3 (establish/continue environmental training programs) and 2.8 (sign and fence boundaries of sensitive or impacted areas) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Environmental education within communities in the region may be a method of informing the public about the illegality and immorality of dumping. The BLM should work with community groups to organize desert clean-ups. Additional signage should be installed at the urban/wildland interface, particularly in areas fraught with dumping activities.

Toxin and Pollutant Deposition

Toxin and pollutant deposition is likely limited to areas around mines and along roads and trails leading into the management area from urbanized areas.

Recommendations

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Roads and routes leading into the management area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the management area, as well as locate new dump sites. Laws pertaining to dumping, camping, and other illegal activities in desert tortoise habitat should be enforced.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). If discovered, dump sites should be restored, and toxins and pollutants removed. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Collection and Poaching by Humans

The threat of tortoise collection and poaching is difficult to measure within the management area, but data from other studies suggest that this threat is likely affecting desert tortoise populations there. Collection and poaching of tortoises – as well as other human behaviors that contribute to killing tortoises – would likely occur in areas that provide the easiest opportunities for human access within the management area, particularly along roads, near urban areas, and in areas frequented by OHV users and recreationists.

Recommendations

- Implement Recovery Actions 2.3 (establish/continue environmental training programs) and 2.8 (sign and fence boundaries of sensitive or impacted areas) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Environmental education within communities in the region may be a method of informing the public about the illegality of tortoise collecting. Interpretive signage or kiosks may be implemented as methods of informing recreationists of the consequences of illegal collection. Signage should be installed at the urban/wildland interface.

- Implement Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The management area should be patrolled regularly to enforce regulations pertaining to the collection and poaching of tortoises, as well as those pertaining to hunting and target shooting.

Translocation of Tortoise Populations

Translocation was first implemented within the management area in 2007 with the release of more than 600 tortoises that were removed from the Southern Expansion Area in support of the Fort Irwin Land Expansion Project. The tortoises were released into areas that supported populations of resident tortoises. This likely resulted in the disruption of dominance hierarchies and increased competition for cover sites and mates with the resident populations, possibly putting them at risk. Additionally, the translocation was likely stressful for translocated tortoises, and to a lesser degree, the resident tortoises. Increased stress among these populations could possibly lead to higher incidence of URTD.

Recommendations

- Implement Recovery Action 3.4 (implement translocations in target areas to augment populations using a scientifically rigorous, research-based approach) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Given the outcome of the problematic translocation of desert tortoises in support of the Ft. Irwin Land Expansion Project, the BLM should use caution in considering any additional actions that include the translocation of desert tortoise populations into the management area, particularly during drought conditions. Should a translocation be authorized, the BLM should ensure that the effort is carefully planned, implemented, and monitored.

5.2.2 Subsidized Predators

The presence of urbanized areas, landfills, anthropogenic water sources, and roads adjacent to and within the southern portion of the management area, along with the agricultural and ranching communities of Hinkley and Harvard within the management area, provides considerable opportunities for predators to obtain human subsidies. Predation pressure from subsidized predators likely includes a considerable portion of the management area. High rates of juvenile tortoise predation by common ravens and coyotes have been documented at the Fort Irwin Study Site, located within the management area (M. Tuma, personal observation). High rates of predation of adult desert tortoises have also been observed within the management area. Following the drought of 2006-2007 and the subsequent crash of prey (black-tailed jackrabbit and white-tailed antelope squirrel) populations, coyotes turned to preying on desert tortoises, and were responsible for inflicting high rates of predation on translocated and resident desert tortoises (Esque et al. 2009; Esque et al. 2010). Other studies have documented similar predation by canids during periods of drought (Peterson 1994; Karl 2002b).

Recommendations

- Implement Recovery Actions 2.13 (limit landfills and their effects) and 2.14 (minimize excessive predation on tortoises) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The BLM should ensure that landfill and pond development is limited to areas at least 5 km from the management area boundaries. The BLM should continue to enforce anti-predator attracting measures instituted during the implementation of actions, and monitor their effectiveness. The BLM should enforce a policy of zero dogs within the management area. This should include pets brought in by recreationists or hunters, or entering uncontrolled from local communities, as well as feral dogs. The BLM should develop programs to track population parameters and occurrence locations for feral dogs, coyotes, and common ravens.

- Implement Recovery Action 2.3 (establish/continue environmental training programs) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The BLM should work with local communities to reduce human subsidies to predators within urban environments, particularly along the urban-wildland interface.

5.2.3 Disease

Upper Respiratory Tract Disease, caused by *Mycoplasma* sp., has been implicated as a major cause of desert tortoise declines in the western Mojave Desert since the 1980s when precipitous die-offs were noted. While other threats such as drought might also explain precipitous population declines, URTD should still be viewed and managed as an important cause of mortality in desert tortoise populations. The threat of disease within and adjacent to the management area appears to be associated with urban developments, office buildings, paved roads, and military use areas (Berry et al. 2006; Mack and Berry 2009).

Recommendations

- Implement Recovery Action 2.2 (minimize factors contributing to disease) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Urban developments, paved roads, and human activities that contribute to the introduction of toxins into the environment, such as military activities and mineral extraction activities, should be avoided or minimized within the management area.

- Implement Recovery Action 2.6 (restore tortoise habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). Dump sites and mines should be restored, and toxins and pollutants that cause susceptibility to disease should be removed. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

- Implement Recovery Action 4.4 (quantify the presence and intensity of threats to the desert tortoise across the landscape) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The BLM should participate in efforts to periodically sample desert tortoise populations within the management area to determine their disease status.

5.2.4 Habitat Degradation of Land In-holdings

A significant portion (224,744 acres) of the Superior-Cronese management area is comprised of private land in-holdings, dispersed in a checkerboard-like pattern across the landscape. Though these lands are situated within Critical Habitat for desert tortoise, they could be developed for urbanization, utilities, or mineral extraction, converted to agriculture, or degraded through other land uses like OHV recreation. Since these lands are privately owned, they cannot be managed by the BLM, though habitat destruction or degradation on these lands would certainly affect adjacent federal lands. Additionally, land owners would be permitted to develop roads across BLM-managed lands to access their in-holdings.

Recommendations

- Implement Recovery Action 2.9 (secure lands/habitat for conservation) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The management area contains an abundance of land in-holdings within its boundaries. The BLM should prioritize acquisition of in-holdings that contain desert tortoise habitat to prevent them from becoming urbanized or developed for agriculture or other land use that would destroy or degrade desert tortoise habitat.

- Implement Recovery Action 2.11 (connect functional habitat) as detailed in the 2011 Revised Recovery Plan (USFWS 2011). The BLM should prioritize acquisition of in-holdings that connect desert tortoise habitat areas.

5.3 Additional Recommendations

In addition to prioritizing the management of threats within desert tortoise habitat areas, the following measures are recommended for the entire management area:

- A more prominent presence of law enforcement with BLM rangers should be applied to the management area, consistent with Recovery Action 2.4 (increase law enforcement) as detailed in the 2011 Revised Recovery Plan (USFWS 2011).

- The 1994 Recovery Plan recommends implementing appropriate administration, including a reserve manager, additional staff, and law enforcement personnel. These additional staff should reach out to the public through meeting with various user groups, forming local advisory

committees, and developing educational and tourism opportunities. Additionally, the 2011 Revised Recovery Plan (USFWS 2011) recommends developing and building partnerships with other agencies to facilitate coordinated efforts toward desert tortoise population recovery (Recovery Action 1). These recommendations should be pursued at the California Desert District Office, with assistance from the Barstow Field Office.

- Per Recovery Action 4 (monitor progress toward recovery) as detailed in the 2011 Revised Recovery Plan (USFWS 2011), the BLM should cooperate with and assist USFWS efforts in implementing annual line distance sampling surveys in support of their range-wide population monitoring. Additionally, desert tortoise populations throughout the Superior-Cronese management area may be monitored with periodic surveys of previously established Permanent Study Plots Survey of the plots every five years would, over the long term, allow the BLM to assess whether implementation of land management measures or removal of threats is affecting local desert tortoise populations. This would additionally satisfy Guideline 39 in the CSDTMP, which recommends that study plots be established to evaluate management effectiveness.

- There is no accounting of the implementation of management measures within the management area, including those performed for desert tortoise recovery, in the public record. The California Desert District should implement a policy of annual reporting of management measures performed in support of desert tortoise recovery to better track the progress of recovery efforts.

- If, through population monitoring efforts, it is determined that desert tortoise population declines or extirpations have occurred within portions of the management area, the BLM should implement Recovery Action 3 (augment depleted populations through a strategic program) as detailed in the 2011 Revised Recovery Plan (USFWS 2011).

- Per Recovery Action 5 (conduct applied research and modeling in support of recovery efforts within a strategic framework) as detailed in the 2011 Revised Recovery Plan (USFWS 2011), the BLM should fund research projects that investigate methods for restoration of vegetation communities in disturbed areas; and methods for controlling the spread of invasive annual plants.

- The BLM should continue to implement Recovery Actions 6.3 (amend land use plans, habitat management plans, and other plans as needed to implement recovery actions) and 6.4 (incorporate scientific advice for recovery through the Science Advisory Committee) as detailed in the 2011 Revised Recovery Plan (USFWS 2011).

- The BLM should continue to collect data that would strengthen the HexSim population model. Important considerations for future research include testing hypotheses advanced by the modeling effort, particularly questions pertaining to the effects of threats on limiting population growth and occupancy of habitat by tortoises.

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Appendix A

Appendix A: Preliminary Analyses of Threats and Population Trends

Final Report for Phase 1 of Desert Tortoise Research on BLM Lands within the Gold Butte-Pakoon and Superior-Cronese Conservation Areas

Prepared for:

Bureau of Land Management
National Office
1620 L Street NW
Washington, D.C. 10036
Contract Officer's Technical Representative: Frank Quamen

Prepared by:
SWCA Environmental Consultants
625 Fair Oaks Avenue, Suite 190
South Pasadena, California 91030
Principal Investigator: Michael W. Tuma

December 31, 2010

SWCA Project Number: 14944
BLM BPA Contract Number: L08PD04646

EXECUTIVE SUMMARY

Purpose and Scope: The Bureau of Land Management (BLM) awarded a contract to SWCA Environmental Consultants (SWCA) to conduct research into desert tortoise populations on BLM lands (Conservation Areas) within and near the Superior-Cronese and the Gold Butte-Pakoon Critical Habitat Units. The primary goal of the research is to develop site-specific conservation plans for BLM lands within each of these Conservation Areas. The conservation plans will be developed through (1) examining historical trends in landscapes, recovery action implementation, and responses of desert tortoise populations over time, focusing on the period of time since listing (1990) to the present, (2) examining the range of site-specific threats to desert tortoise populations in each Conservation Area, (3) developing a computer model that conducts population viability analyses (PVAs) for each of the Conservation Areas in order to model the effects of the threats on desert tortoise populations, (4) prioritizing threats through the modeling effort, and (5) developing site-specific conservation plans based upon the threat prioritization within each of the Conservation Areas. The following report summarizes research activities undertaken by SWCA toward completion of the first phase of the project issued in the first Work Order, which includes: (1) developing a set of maps depicting suitable and occupied desert tortoise habitat within each of the Conservation Areas, both at the time of listing and at present, using aerial photography or remote sensing; (2) further developing habitat suitability maps using soils, elevation, vegetation communities, and other key habitat variables; (3) using all available desert tortoise location information to further refine habitat suitability in each of the Conservation Areas and to determine those portions of the suitable habitat which are currently occupied; (4) characterizing changes in both suitable habitat and desert tortoise population distributions from 1990 to 2008; (5) summarizing changes to relevant land use plans for each of the Conservation Areas from 1994 to present; (6) summarizing progress and effectiveness of the implementation of management recommendations for desert tortoise within the current land use plans; (7) assessing the level of law enforcement within the Conservation Areas between 1994 and 2008; (8) conducting a spatial analysis of threats and their changes between 1994 and the present within each of the Conservation Areas; (9) developing a thorough review of threats within each Conservation Area; (10) developing a preliminary prioritization of the threats, with rationalization for their ranking; (11) determining how the threats should be characterized for incorporation into the HexSim model through discussions with Josh Lawler's lab; (12) evaluating the status of the Specific Management Actions identified in Appendix F of the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a) for each of the Conservation Areas; (13) recommending which actions identified in the 1994 Desert Tortoise Recovery Plan (if any) should be given priority consideration for implementation by BLM or land managers, based on the results of the threats analysis; and (14) prepare a report describing the recommendations and the rationale for their prioritization. The following report also includes a presentation of pertinent data collected during Phase II of the project – field data collection in the Gold Butte-Pakoon Conservation Area – that allow for a more detailed analysis of threats within the Conservation Area.

Key Findings: Based upon historical, anecdotal observations, tortoise populations in the Gold Butte-Pakoon Conservation Area may have declined between 1990 and the present; however, insufficient population monitoring data across multiple survey years, inconsistency in quality and quantity of data among survey areas and among DWMAs, and a lack of supporting evidence makes inferences about population declines in the Northeast Mojave Recovery Unit problematic. Field data indicates that populations exist in varying densities within the Conservation Area. The apparent decline of desert tortoise populations within the Western Mojave Recovery Unit, where the Superior-Cronese Conservation Area is located, is better substantiated with monitoring data and research investigations. Data collected from PSPs in other portions of the Western Mojave Recovery Unit generally show that tortoise populations have experienced statistically significant declines throughout the region (Tracy et al. 2004). In addition, kernel analyses revealed large areas within the West Mojave where carcasses are expected but

live animals are not (Tracy et al. 2004). The largest declines in densities for all size classes and for breeding females (up to 90%) occurred in the Western Mojave between the 1970s and 1990s (Berry and Medica 1995). Berry and Medica (1995) included anthropogenic causes as one of the reasons for the decline. Desert tortoise populations occurring in relatively undisturbed and remote areas with little vehicular access and low human visitation were relatively stable compared with populations in areas with high levels of disturbance, high vehicular access, and high human visitation (Berry and Medica 1995). Furthermore, approximately 14.6 percent to 28.9 percent of desert tortoises collected from Western Mojave plots in the 1970s and early 1980s showed signs of gunshots. Mortality related to vehicles was also greater in this area, where densities of dirt roads and vehicle trails are greater than other areas (Berry and Medica 1995). Other studies in this region have cited drought as a possible cause for the observed increases in mortality (Corn 1994; Karl 2002a). Demographic modeling of desert tortoise population viability in the Western Mojave based upon PSP data has suggested that populations there are at very high risk of further decline (Doak et al. 1994).

The habitat model predicted areas of "good" and "better" desert tortoise habitat within the Conservation Areas. Desert tortoise occurrence data indicated strong agreement with the predicted habitat model. The majority of known desert tortoise occurrences were included within areas that we modeled as "good" or "better" habitat in the model. Within the Gold Butte-Pakoon Conservation Area, 228 (95.4%) of 239 tortoise occurrences were included in the habitat model; within the Superior-Cronese Conservation Area, 765 (99.7%) of 767 tortoise occurrences were included in the habitat model.

Analysis of the various threats to desert tortoises, including human developments (urbanization, roads, railroads, utilities, landfills, and anthropogenic water sources), human activities and by-products of activities (OHV use, livestock grazing, agricultural practices, mineral extraction, military activities, litter and illegal dumping, toxin and pollutant deposition, degradation of air quality, climate change, collection/poaching of tortoises by humans, and translocation of tortoise populations), and biological and environmental threats (invasive plants, fire, disease, subsidized predators, and drought) within each of the Conservation Areas indicated threats are site-specific, and threats affected tortoise populations within each of the Conservation Area in markedly different manners and levels of severity. Based upon how these threats contributed to 1) desert tortoise mortality; 2) habitat loss, fragmentation, or degradation; 3) facilitation of human access to areas supporting desert tortoise populations; 4) interactions with and cumulative effects with additional threats; 5) their occurrence or potential for occurrence on private, state, or federal land in-holdings; and 6) their distribution or occurrence within each of the Conservation Areas, a preliminary ranking of threats within each of the Conservation Areas was developed. Important threats in the Gold Butte-Pakoon Conservation Area included livestock grazing, fire, invasive plants, roads, climate change, and subsidized predators; within the Superior-Cronese Conservation Area they included roads, climate change, invasive plants, subsidized predators, urbanization, drought, collection and poaching of tortoises by humans, translocation of tortoise populations, agricultural practices, OHV use, disease, and mineral extraction.

Recommendations: A review of BLM land use and management plans indicated that policies aimed at protecting desert tortoise populations have generally followed recommendations provided in Appendix F of the 1994 Desert Tortoise Recovery Plan. One exception is livestock grazing. The USFWS recommended closure of grazing allotments within all DWMAs, but most BLM field offices pursued continued grazing under the Interim Livestock Grazing Program. Grazing allotments on BLM-managed lands within the Nevada portion of the Gold Butte-Pakoon Conservation Area were closed in 1998; grazing allotments within the Arizona portion of the Conservation Area were closed in 2008. Illegal trespass grazing continues in both the Nevada and Arizona portions of the Conservation Area. Grazing allotments within the Superior-Cronese Conservation Area were closed in 2006 as part of a mitigation measure for the Fort Irwin Land Expansion project. The other recommended Specific Management Actions in Appendix F of the 1994 Recovery Plan have largely been included in BLM land use plans;

however, implementation and enforcement of the measures and policies needs improvement. The threats ranking allowed for the development of management priorities for each of the Conservation Areas, and additional recommendations are provided that would aid in further implementing the Specific Management Actions at the site-specific level, as well as monitoring and reporting of the effects of implemented desert tortoise recovery efforts. The findings of Phase I of the project should be considered preliminary in nature, as more detailed analysis of threats prioritization and more accurate and refined management recommendations will be developed during Phase III.

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LIST OF ACRONYMS

AADT: Annual Average Daily Traffic
ACEC: Area of Critical Environmental Concern
ADT: Average Daily Traffic
AMP: Allotment Management Plan
ASDRMP: Arizona Strip District: Resource Management Plan (1992, Amended 1998)
ASRMP: Arizona Strip Resource Management Plan (2008)
AZGFD: Arizona Game and Fish Department
BLM: Bureau of Land Management
BPA: Blanket Purchase Agreement
CDCA: California Desert Conservation Area
CSDTMP: California Statewide Desert Tortoise Management Policy (1993)
DEM: Digital Elevation Model
DTHMPL: Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan (1998)
DTNA: Desert Tortoise Natural Area
DTRPAC: Desert Tortoise Recovery Plan Assessment Committee
DWMA: Desert Wildlife Management Area
EEA: Eastern Expansion Area
ELISA: Enzyme-linked Immunosorbent Assay
EMZ: Experimental Management Zone
ESA: Endangered Species Act
GAO: Government Accountability Office
GIS: Geographic Information Systems
IPCC: Intergovernmental Panel on Climate Change
km: Kilometer
LDS: Line Distance Sampling
LVRMP: Las Vegas Resource Management Plan (1998)
MDEP: Mojave Desert Ecosystem Program
MFP: Clark County Management Framework Plan (1983)
MSHCP: Clark County Multiple Species Habitat Conservation Plan (2000)
MSL: Mean Sea Level
NDOW: Nevada Department of Wildlife
NEPA: National Environmental Policy Act
NMRMP: Grand Canyon-Parashant National Monument Resource Management Plan (2008)
NOAA: National Oceanic and Atmospheric Administration
NPS: National Park Service
OHV: Off-highway Vehicle
ppm: Parts Per Million
PSP: Permanent Study Plots
PVA: Population Viability Analysis
RNA: Research Natural Area
ROW: Right-of-way

SEA: Southern Expansion Area
SNPLMA: Southern Nevada Public Land Management Act (1998)
SWCA: SWCA Environmental Consultants
TDSD: Temperature-dependent Sex Determination
TMA: Travel Management Area
URDS: Upper Respiratory Disease Syndrome
URTD: Upper Respiratory Tract Disease
VOC: Volatile Organic Compound
USFWS: U. S. Fish and Wildlife Service
USGS: U.S. Geological Survey
UTM: Universal Transverse Mercator
WEA: Western Expansion Area
WEMO: 2006 West Mojave Plan
WHA: Wildlife Habitat Area

1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Bureau of Land Management (BLM) awarded a contract to SWCA Environmental Consultants (SWCA) to conduct research into desert tortoise populations on BLM lands (Conservation Areas) within and near the Superior-Cronese and the Gold Butte-Pakoon Critical Habitat Units. The primary goal of the research is to develop site-specific conservation plans for BLM lands within each of these Conservation Areas. The Conservation Areas are located within the Western Mojave (Superior-Cronese) and Northeastern Mojave (Gold Butte-Pakoon) Recovery Units for the Mojave population of the desert tortoise. The conservation plans will be developed through (1) examining historical trends in landscapes, recovery action implementation, and responses of desert tortoise populations over time, focusing on the period of time since listing (1990) to the present, (2) examining the range of site-specific threats to desert tortoise populations in each Conservation Area, (3) developing a computer model that conducts population viability analyses (PVAs) for each of the Conservation Areas in order to model the effects of the threats on desert tortoise populations, (4) prioritizing threats through the modeling effort, and (5) developing site-specific conservation plans based upon the threat prioritization within each of the Conservation Areas.

The initial Work Order issued by the BLM includes: (1) mapping landscape variables in an effort to characterize desert tortoise habitat within each of the Conservation Areas, (2) assessing desert tortoise population data for each of the Conservation Areas and examining population trends from the time of listing to the present, (3) assessing the range of threats within each of the Conservation Areas and mapping the spatial occurrences of the threats, and (4) examining the influences that changing landscape variables and threats have had on desert tortoise population trends from the time of listing to the present. These tasks will serve in: (1) providing baseline data for the HexSim model, a computer-based population viability modeling program developed by Josh Lawler (University of Washington) and Nathan Schumaker (U.S. Environmental Protection Agency) that considers spatial landscape and threat data during the development of the PVAs and (2) detecting historical trends in landscape use, recovery actions, threats occurrence, and desert tortoise population trends, which will aid in assessing the effectiveness of historic recovery actions implemented by the BLM and allow SWCA to calibrate the HexSim model using historical data.

SWCA was recently awarded a second Work Order to begin fieldwork within the Gold Butte-Pakoon Conservation Area. The purpose of this task is to collect ecological, life history data, and threats data that will be used to construct the HexSim model. Since the Gold Butte-Pakoon Conservation Area is a relatively understudied portion of the desert tortoise's range, these data will be particularly useful for filling in gaps of knowledge and building the model. We anticipate that future Work Orders will include: (1) compiling and assessing biological data (life history, ecological, and threats) previously collected from desert tortoise populations within and near the Superior-Cronese Conservation Area; (2) constructing the HexSim model; (3) prioritizing threats through HexSim PVA simulations; and (4) developing site-specific management plans designed to eliminate or minimize the effects of threats to desert tortoise populations within each of the Conservation Areas.

The following report summarizes research activities undertaken by SWCA toward completion of the first phase of the project (BASIC through Option 3 Tasks) issued in the first Work Order. The following report is a draft final report that builds upon information previously presented in the 90 percent completion report submitted in July 2009, including additional spatial data that have been collected in support of the tasks, refining literature reviews and temporal analysis in support of threats ranking within each of the Conservation Areas, and developing a discussion of the management history pertaining to desert tortoises in each of the Conservation Areas.

1.2 RESEARCH RATIONALE

1.2.1 USFWS Recovery Actions and Recommendations

Endangered Species Act Listing

The Mojave population of the desert tortoise (those populations located north and west of the Colorado River in California, Nevada, Utah, and the northwestern portion of Arizona) was emergency-listed as endangered on August 4, 1989, by the U.S. Fish and Wildlife Service (USFWS) (USFWS 1989). The USFWS subsequently down-listed this population to threatened status in a final rule issued on April 2, 1990 (USFWS 1990). The desert tortoise was listed following concern that several populations had undergone significant and precipitous decline (USFWS 1990). It was believed that epidemic levels of a disease, initially called Upper Respiratory Disease Syndrome (URDS)—now known as Upper Respiratory Tract Disease (URTD)—was responsible for the declines. In the final rule for the desert tortoises' listing, the USFWS identified additional threats to the survival of the species, including habitat loss and degradation caused by human activities such as off-highway vehicle (OHV) use, urbanization, agriculture, energy development, military training, mining, and livestock grazing; loss of individual desert tortoises to increased predation by common ravens (*Corvus corax*); collection by humans for pets or consumption; and collisions with vehicles on paved and unpaved roads (USFWS 1990). The 1994 Desert Tortoise Recovery Plan concluded that these threats cumulatively contributed to desert tortoise population declines in the Mojave region (USFWS 1994a).

Critical Habitat Ruling

In response to lawsuits from several environmental groups, the USFWS published a proposed rule to designate Critical Habitat for the desert tortoise on August 30, 1993 (58 FR 45748). The final rule for the Critical Habitat designation was published on February 8, 1994 (USFWS 1994b), whereby nearly 6.4 million acres were designated. The boundaries of the designated Critical Habitat units generally corresponded to the boundaries of the Desert Wildlife Management Areas (DWMA) that were recommended by the USFWS-appointed desert tortoise recovery team and presented in the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a).

Recovery Plan

<u>1994 Desert Tortoise (Mojave Population) Recovery Plan</u>

The 1994 Recovery Plan outlined criteria for delisting of the Mojave population of the desert tortoise, which included: (1) a statistically significant upward trend or stability of population sizes for at least 25 years, as determined through a monitoring program, (2) protection of desert tortoise populations and habitat within a recovery unit (or intensive management of populations and habitat without recovery unit designation), (3) management within recovery unit(s) must result in population growth rates (λ) at or above 1.0, (4) implementing regulations or land management strategies that provide long-term protection of desert tortoises and their habitat, and (5) continued protection of the population under the Endangered Species Act. Recovery actions recommended in the Recovery Plan included:

(1) Establish DWMAs and implement management plans for each of the six recovery units.

(2) Establish environmental education programs.

(3) Initiate research necessary to monitor and guide recovery efforts.

Additionally, specific recommended recovery actions were identified for each of the DWMAs. Specific recovery actions recommended for the Gold Butte-Pakoon and Superior-Cronese DWMAs are reviewed below.

Gold Butte-Pakoon DWMA

The following Specific Management Actions were recommended for the Gold Butte-Pakoon DWMA:

(1) Remove livestock grazing or, if desired, establish terms for experimental cattle grazing in experimental management zones (EMZs).

(2) Construct desert tortoise barrier fencing along Interstate 15 and Highway 91 to protect desert tortoises from vehicle kills, collection, and vandalism.

(3) Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.

Superior-Cronese DWMA

The following Specific Management Actions were recommended for the Superior-Cronese DWMA:

(1) Remove livestock grazing or, if desired, establish terms for experimental cattle grazing in experimental management zones (EMZs).

(2) Establish a drop-off site for unwanted captive desert tortoises at BLM's Barstow Way Station. Develop programs to make unwanted captives available for research and educational purposes.

(3) Construct barrier fencing along Interstate 15, Ft. Irwin Road, Manix Trail, Superior Lake Road, and the northern border of the DWMA to protect desert tortoises from vehicles, collection, and habitat degradation.

(4) Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

(5) Construct highway underpasses along Ft. Irwin Road to allow desert tortoise movement and to facilitate genetic exchange throughout this DWMA.

(6) Reduce raven populations in the DWMA to lessen mortality of small desert tortoises to a point at which recruitment into the adult cohort can occur at as rapid a rate as possible.

(7) Initiate cleanup of surface toxic chemicals and unexploded ordnance.

(8) Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts. Along the boundary with the Fremont-Kramer DWMA, a double row of desert tortoise barrier fencing may be necessary to prevent the spread of URTD into the Superior-Cronese DWMA.

1.2.2 BLM Needs for Desert Tortoise Management

Threats to desert tortoises and their habitat have previously been reviewed, including threats reviews in the USFWS recovery plans (USFWS 1994a; USFWS 2008a) and reviews by the USGS (Boarman 2002a) and the Desert Tortoise Recovery Plan Assessment Committee (Tracy et al. 2004). These reviews discuss

threats in a general manner within the context of the entire Mojave desert tortoise population (with the exception of Boarman [2002a], which discussed threats in the Western Mojave Desert). Accordingly, because the threats reviews were generalized (and sometimes based on anecdotal data), the recommendations provided by the USFWS (1994a and 2008) are likewise general, and provided little direction to local land managers for conserving and managing desert tortoises at the site-specific level. Furthermore, the Specific Management Actions provided within the 1994 Recovery Plan (USFWS 1994a) do not contain a prioritization of management strategies based on the severity of threats or their effect on tortoise populations, as the data that would support this approach were generally unknown when the plan was developed (GAO 2002). Since little was known about the effects of threats on desert tortoise populations when the recommendations were developed, some of the Specific Management Actions may be uninformed and possibly misguided.

A number of the Specific Management Actions have been implemented since publication of the 1994 Recovery Plan (USFWS 1994a), but there has been no synthesis performed of the Specific Management Actions (USFWS 2008:42), nor an analysis or understanding of their efficacy. Since publication of the 1994 Recovery Plan (USFWS 1994a), the BLM has implemented a number of the Specific Management Actions, but no research has been conducted to determine whether implementing these action resulted in a benefit for desert tortoises or their habitat. In particular, it is poorly understood whether restricting OHV use, livestock grazing, or other activities in desert tortoise habitat has resulted in an improvement in desert tortoise habitat or a leveling or reversing of population declines. The effects of other management actions, such as fencing roads, closing mines, increasing law enforcement, and restoring habitat, are similarly unknown. For these reasons, the Government Accountability Office (GAO 2002) recommended that the USFWS and land management agencies develop and implement a coordinated research strategy to develop land management decisions with research results.

The goal of the present study, therefore, is to overcome deficiencies in previous threats analyses and management recommendations by 1) examining and prioritizing threats at a site-specific level, 2) analyzing the effects of any previously implemented management strategies, 3) and developing conservation and management priorities for tortoise populations at a fairly localized level. This analysis will ultimately provide local BLM land managers with site-specific conservation plans.

1.3 RESEARCH OBJECTIVES

The following section describes the objectives of the tasks under the first Work Order, as defined in the scope of work provided by the BLM.

1.3.1 BASIC Task

The objectives of the BASIC Task are to: (1) develop a set of maps depicting suitable and occupied desert tortoise habitat within each of the Conservation Areas, both at the time of listing and at present, using aerial photography or remote sensing, (2) further develop habitat suitability maps using soils, elevation, vegetation communities, and other key habitat variables, (3) use all available desert tortoise location information to further refine habitat suitability in each of the Conservation Areas and to determine those portions of the suitable habitat which are currently occupied, and (4) characterize changes in both suitable habitat and desert tortoise population distributions from 1990 to 2008.

1.3.2 Option 1 Task

The objectives of the Option 1 Task are to: (1) summarize changes to relevant land use plans for each of the Conservation Areas from 1994 to present, (2) summarize progress and effectiveness of the implementation of management recommendations for desert tortoise within the current land use plans, (3) assess the level of law enforcement within the Conservation Areas between 1994 and 2008, and (4) conduct a spatial analysis of threats and their changes between 1994 and the present within each of the Conservation Areas.

1.3.3 Option 2 Task

The objectives of the Option 2 Task are to: (1) develop a thorough review of threats within each Conservation Area, (2) develop a preliminary prioritization of the threats, with rationalization for their ranking, and (3) determine how the threats should be characterized for incorporation into the HexSim model through discussions with Josh Lawler's lab.

1.3.4 Option 3 Task

The objectives of the Option 3 Task are to: (1) evaluate the status of the Specific Management Actions identified in Appendix F of the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a) for each of the Conservation Areas, (2) recommend which actions identified in the 1994 Desert Tortoise Recovery Plan (if any) should be given priority consideration for implementation by BLM or land managers, based on the results of the threats analysis, and (3) prepare a report describing the recommendations and the rationale for their prioritization.

2. METHODS

2.1 CONSERVATION AREA LOCATIONS AND DESCRIPTIONS

The Conservation Areas are composed of BLM lands within designated DWMAs. The Conservation Areas typically also correspond with BLM-designated Areas of Critical Environmental Concern (ACEC), which were established "to protect and prevent irreparable damage to important historical, cultural, or scenic values, fish and wildlife resources, or other natural systems or process, or to protect life and safety from natural hazards" as well as designated Critical Habitat for desert tortoise.

The Gold Butte-Pakoon Conservation Area totals 611,358 acres and includes the Gold Butte ACEC (Part A and Part B) in Nevada and portions of the Pakoon Basin in Arizona. This Conservation Area includes 488,821 acres of Critical Habitat for desert tortoise designated within Part A of the Gold Butte ACEC in Nevada and the Pakoon Basin in Arizona, collectively comprising the Gold Butte-Pakoon DWMA. Additionally, the Conservation Area includes 122,537 acres in Gold Butte ACEC Part B, where there is no designated Critical Habitat. This Conservation Area is located within the Northeastern Mojave Recovery Unit (Figure 1). There are three privately owned in-holdings on the Nevada side of the Conservation Area totaling 320 acres. There are 20 in-holdings on the Arizona side of the Conservation Area, including eight privately owned in-holdings (198 acres) and 12 state-owned in-holdings (totaling 2,263 acres). There are seven ACECs, four Wilderness Areas, and one Wildlife Habitat Area (WHA) wholly or partially within the Conservation Area, including the Gold Butte ACEC (185,138 acres), the Virgin Slope ACEC (38,548 acres), the Red Rock Springs ACEC (638 acres), the Devil's Throat ACEC (639 acres), the Whitney Pocket ACEC (160 acres), a portion of the Virgin Mountains ACEC (1,546 acres), the Gold Butte town site ACEC (159 acres), the Lime Canyon Wilderness Area (23,234 acres),

Jumbo Springs Wilderness Area (4,631 acres), portions of the Paiute (10,926 acres) and Grand Wash Cliffs (22,553 acres) Wilderness Areas, and the Pakoon WHA (171,709 acres). The southeastern portion (45,740 acres) of the Conservation Area occurs on Lake Mead National Recreation Area, and is co-managed by the National Park Service (NPS). Prominent and ongoing land uses in the Conservation Area include livestock grazing and off-highway vehicle (OHV) use.

The Superior-Cronese Conservation Area totals 629,697 acres and includes the entire designated desert tortoise Critical Habitat within the Superior-Cronese DWMA (570,652 acres), with the exception of lands included in the Fort Irwin Land Expansion. This Conservation Area is located within the Western Mojave Recovery Unit (Figure 2). Six ACECs and two Wilderness Areas are wholly or partially included within the Conservation Area, including the Black Mountain Wilderness Area (20,935 acres), the Grass Valley Wilderness Area (32,841 acres), the Black Mountain ACEC (61,790 acres), the Rainbow Basin ACEC (4,102 acres), the Coolgardie Mesa ACEC (13,248 acres), the West Paradise ACEC (1,237 acres), the Parish's Phacelia ACEC (899 acres), and a portion of the Cronese Basin ACEC (2,440 acres). The Conservation Area also includes an archaeological park—the Calico Early Man Site (895 acres). The Conservation Area is characterized by substantial private land ownership, including 191 in-holdings distributed in a checkerboard-like fashion and totaling 224,744 acres. In addition, there are 19 state-owned in-holdings totaling 9,793 acres and two federally owned in-holdings totaling 8,690 acres. Eight of the private in-holdings (totaling 37,028 acres) are owned by conservancies, and nine of the state in-holdings (totaling 4,914 acres) are Ecological Reserves managed by the California Department of Fish and Game. Prominent land uses in the Conservation Area include OHV use, utility development, military activities, mining, and agriculture.

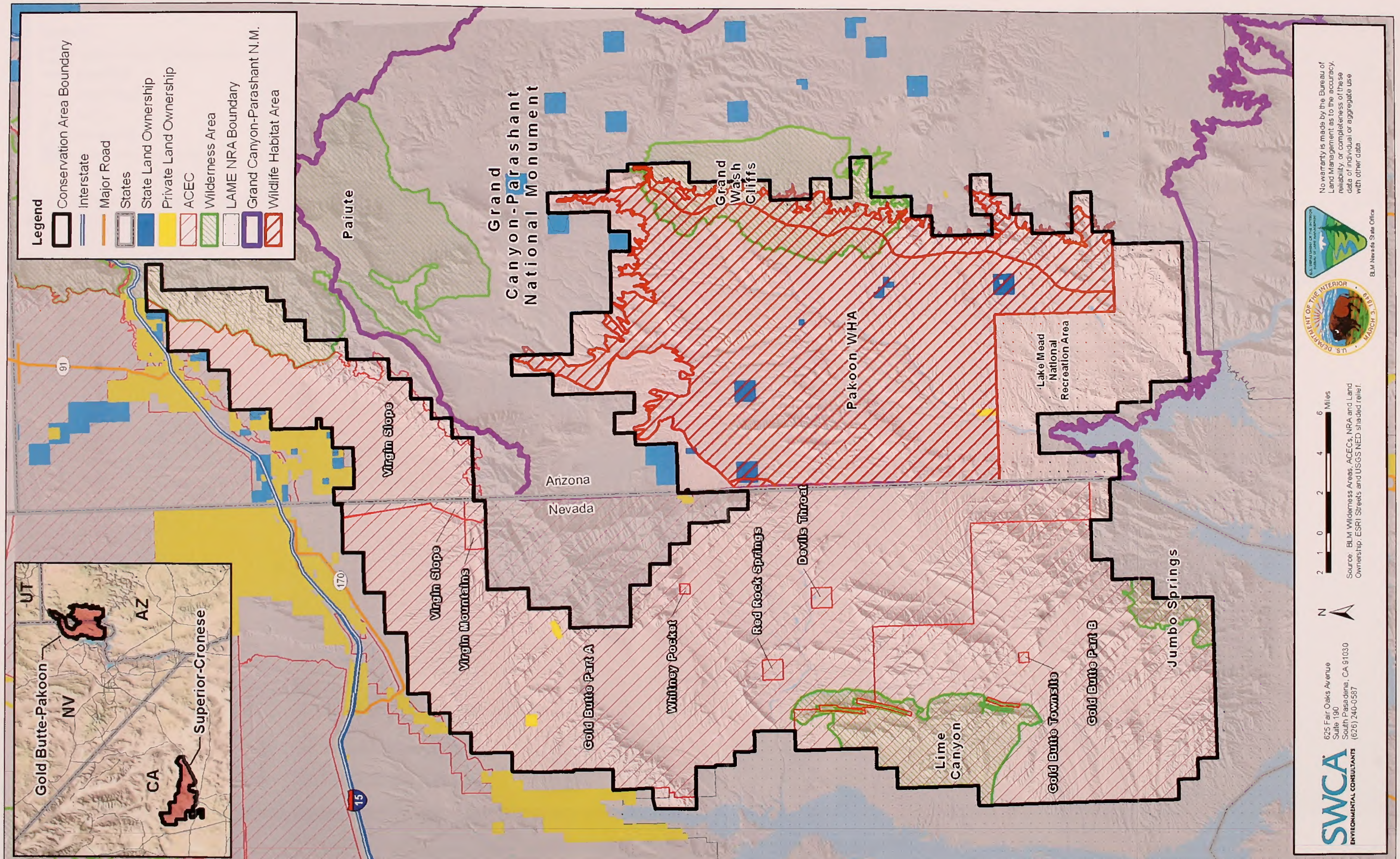

Figure 1. Gold Butte-Pakoon Conservation Area Overview

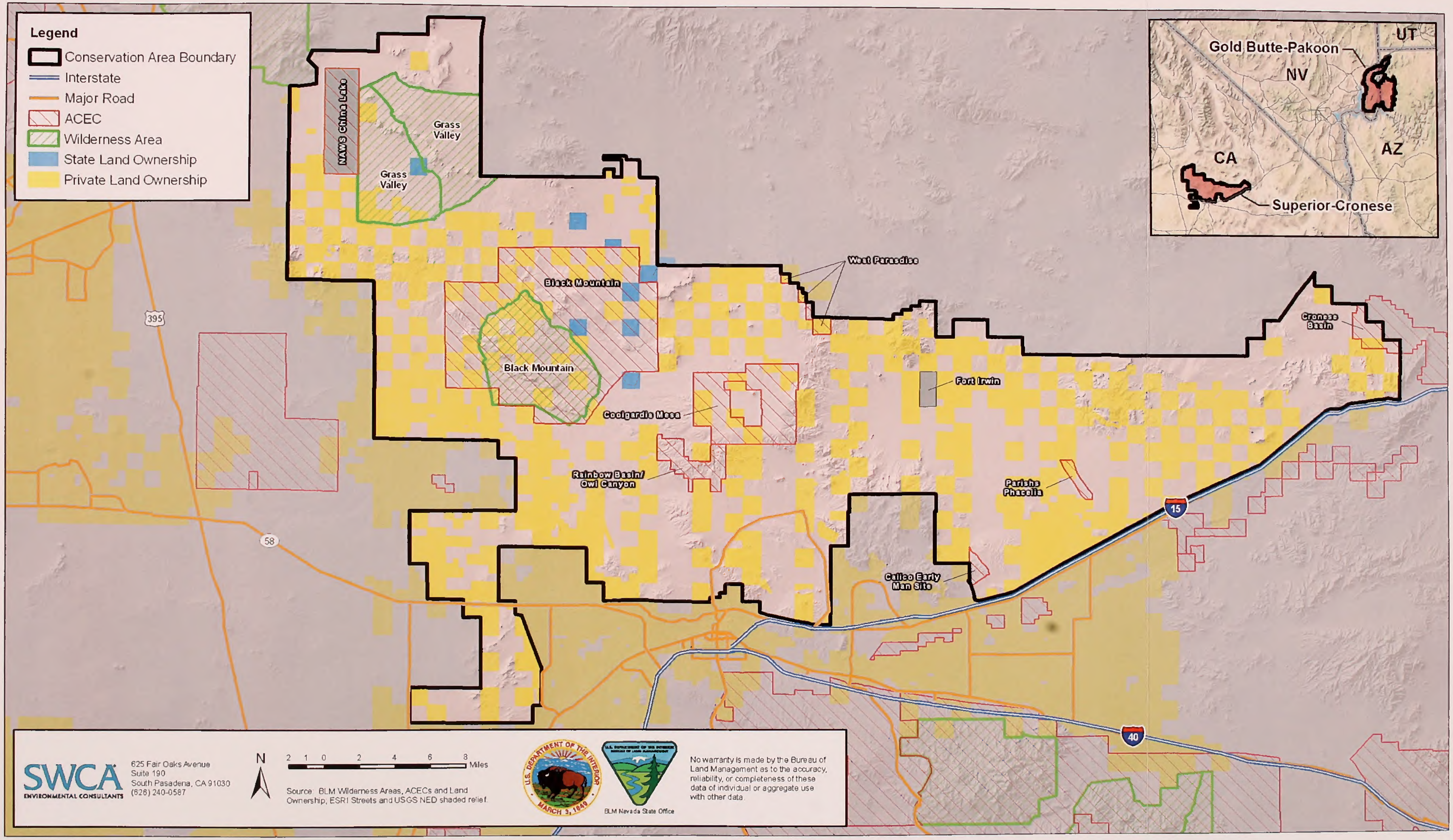

Figure 2. Superior-Cronese Conservation Area Overview

2.2 Compilation of Spatial Data

We compiled spatial data pertaining to landscape variables and threats from several datasets, including those collected and maintained by the Redlands Institute, the BLM (Nevada, Arizona, and California Field Offices), the Mojave Desert Ecosystem Program (MDEP), USFWS, National Park Service (NPS), and the U.S. Geological Survey (USGS). These data were compiled for the purposes of modeling desert tortoise habitat potential and threats within the Conservation Areas, and fulfill the objectives of the BASIC and Option 1 Tasks.

We organized the datasets by (1) eliminating data that were deemed inappropriate, were at scales that were not useful, or were spatially irrelevant to the objectives of the study; (2) eliminating duplicate datasets; and (3) clipping the datasets to the Conservation Area boundaries. Entity and attribute information were also examined for their suitability in the study. Following organization of the datasets, SWCA geographic information systems (GIS) specialists performed an iterative process with biologists to determine the utility of the spatial data, determine how they contribute to answering questions regarding habitat potential or threats to desert tortoises, and create a master database.

2.3 Remote Sensing Techniques

We compiled and initiated analysis of remotely sensed datasets to track changes in vegetation within each of the Conservation Areas from 1990 to 2008. Datasets compiled in support of the remote sensing included Land Cover Datasets, the 2001 National Land Cover Dataset, the 1992 National Land Cover Retrofit, GAP (SWReGAP and CALGAP), and Landsat Imagery.

Landsat Imagery data were sampled at three intervals between 1990 and 2008, including 1990, 2001, and 2008. Imagery was downloaded from the USGS GLOVIS website (http://glovis.usgs.gov). Images were chosen for a similar time of year (mid-May through mid-June). Cloud-free images were selected to avoid masking out clouds and shadows. All of the imagery was converted from calibrated radiance to at-satellite reflectance (Chander et al. 2007; USGS 2006). In the case of Gold Butte-Pakoon, a mosaic of two scenes was performed. These images were then clipped to the extent of the minimum bounding rectangle of each of the study areas buffered to 1 mile.

To identify areas of change, the three intervals of imagery were stacked and a principal component analysis was performed. Stacking enabled the identification of spectral variation throughout the time series and maximized it in a new data layer. An independent component analysis also helped in determining and maximizing the change components (Xiao et al. 2008). After evaluating the principal component analysis and independent component analysis results, a subset of components was selected based on its response to land cover change. The primary agent of change in this case was the removal of vegetation, which could occur through fire, urbanization/development, clearing for energy transmission corridors, and other land uses that resulted in surface disturbances.

The chosen components were stacked into one change-representative dataset, and iso-data classifications were conducted to identify clusters of data corresponding to real change. Areas of change were verified using Google Earth imagery from multiple dates and Digital Ortho Quarter Quads. While the datasets were georegistered, differences in soils moisture, shadow, and slight imagery registration errors contributed to false change. These areas were manually identified and taken out of the change mask. This final change mask was applied to the vegetation and land cover classifications to make a modified dataset describing current conditions and changes.

Following development of a preliminary vegetation change assessment, areas of detected change were verified through field reconnaissance. Field visits consisted of determining the cause of change in areas where change could not be attributed to a particular threat, as well as ground-truthing areas of change that had been attributed to a particular threat in preliminary analyses.

Following the preliminary analysis and field verification, changes were quantified. To quantify observed changes, the land cover change layer was cross-tabulated with existing habitat and land cover datasets. This summary provided habitat loss and percentage change through the period under study (1990–2008). This analysis of vegetation change allowed us to track the effects of threats over time, fulfilling the objectives of the Option 1 Task.

2.4 HABITAT MODELING

2.4.1 Landscape Variables

To develop a habitat model as required under the BASIC Task, we compiled a series of landscape variables that describe desert tortoise habitat from two primary sources, including the Redlands Institute's Habitat Potential Knowledge Base (Redlands Institute 2004) and Todd Esque's (USGS) current desert tortoise habitat modeling project (Todd Esque, personal communication, January 26, 2009; Nussear et al. 2009). In modeling desert tortoise habitat potential, five primary landscape variables were selected, including geomorphology, soils, elevation, vegetation, and precipitation. These variables were selected because they account for most of the conditions that adequately describe important desert tortoise habitat. Below, we provide descriptions of the rationale for selecting these variables and methods for assessing habitat potential through their mapping.

Geomorphology

Geomorphological features in the landscape have a profound effect on the distribution of desert tortoises; thus, considering geomorphological data is critical in assessing habitat potential for this species. Throughout most of the Mojave Desert, tortoises occur most commonly on gently sloping terrain, but may also be found in steeper, rockier areas (USFWS 1994a). Luckenbach (1982) reported that throughout the Mojave Desert, desert tortoises are often found on valley bottoms and on bajadas. He indicated that tortoises were not associated with rocky hillsides; however, he noted that the lack of sightings of tortoises on hillsides might be because little effort has occurred outside of valleys where tortoises are abundant (Luckenbach 1982). Recent evidence from the Fort Irwin desert tortoise translocation indicates that tortoises inhabit steep, rocky hills (Danna Hinderle, personal communication, March 2009); however, little is known regarding the reasons for or relative intensity of use in selection of steep hillsides vs. desert flats by tortoises. Anderson et al. (2000) modeled desert tortoise habitat using regression-tree analysis, and found that tortoises occurred in higher densities on southwest-facing slopes within their study area in the central Mojave Desert. Jennings (1997a) observed that tortoises preferred washlets, washes, and hills in most instances (92%) over desert flats (8%) at the Desert Tortoise Natural Area in the western Mojave Desert.

Examining geomorphological features of the landscape can provide additional information on the potential for retreat site and foraging habitats. Desert tortoises in the Mojave Desert typically use cover sites such as soil burrows, pallets, and caliche caves (Bulova 1994; O'Connor et al. 1994), and selection of cover sites is influenced by the tortoises' need to maintain energy and water balance. In particular, desert tortoises will select cool, deep cover sites to minimize evaporative water loss and maintain body temperatures below daytime ambient surface temperatures (Zimmerman et al. 1994). Surveys at two sites on Fort Irwin (Berry 1999) indicate that caliche caves were a much more important retreat site than soil

burrows, with 68.9 percent and 60.6 percent of tortoises occurring within caliche caves, as opposed to 16.2 percent and 12.1 percent within soil burrows. Recent evidence suggests that when caliche caves are available, they are very important retreat sites—particularly during hot summer and cold winter inactivity periods—and are disproportionately used over soil burrow sites (Goodman et al. 2009). When not occupying cover sites, desert tortoises often retreat under shade resources to thermoregulate. Though shrubs are most often chosen for shade, geomorphological characteristics in the landscape also provide appropriate shade resources. In addition to cover site habitat, foraging and drinking sites are likely important microhabitat components. Baxter (1988) examined habitat use by desert tortoises at Twentynine Palms, and determined that tortoises preferred placing burrows at the edges of washes and vegetation community ecotones, suggesting that tortoises positioned burrows close to rich foraging areas. Jennings (1997a) observed tortoises within habitats that supported preferred forage, including desert wishbone and two-seeded milkvetch on hills, and Layne's milkvetch and Booth's evening primrose, along washlet margins. Finally, washlets on hillsides, flat boulder exposures, and other areas where water accumulates provide important drinking features during rain events and are an important microhabitat characteristic for desert tortoises in the Mojave Desert.

Thus, examining geomorphological characteristics of the landscape can be extremely informative in describing potential desert tortoise habitat. To map the geomorphology of the landscape within each of the Conservation Areas, we mapped digital elevation models (DEMs) and hydrographical data (from the USGS National Hydrography Dataset) to create surface models; understand flow regimes, watersheds, and washes; and determine elevation ranges as a way to further define potential caliche outcrop retreat sites, steepness in slope, aspect, shade, and other topographic features.

Soils

Mapping of soils within each of the Conservation Areas will allow for the characterization of habitat potential with respect to soil burrow and caliche cave sites, and potential to support appropriate foraging habitat. Desert tortoises are known to occur over a range of soil types, which will facilitate the habitat potential assessment using this variable. Luckenbach (1982) reported that desert tortoises occupied areas characterized by soil types varying from gravelly flats to sand soil with some clay, to fine windblown sand and stabilized dunes. He reported that the most favorable habitats within California were characterized by sandy loam or light gravelly clay soils that provided good burrowing habitat, and that tortoises are absent or scarce in most windblown sand areas (Luckenbach 1982). Andersen et al. (2000) found that higher tortoise densities were encountered in areas with loamy soils.

In addition to mapping appropriate burrowing soils, mapping the locations of soils derived from caliche as a parent material may aid in determining the potential for caliche caves. Caliche is a calcium carbonate ($CaCO_3$) soil horizon commonly observed as resistant layers within alluvium or as hardpan in arid environments such as the Mojave Desert. The formation of caliche results from the precipitation of calcium carbonate in lower horizons of arid and semi-arid soils (Marion et al. 1985; Schlesinger 1984). The formation of caliche is dependent on climate, parent material, time, topography, and biota. Parent material affects caliche deposition in two distinct ways. First, soils that formed on calcareous parent material accumulate caliche at a greater rate than those that formed on non-calcareous parent material. Second, parent material affects the water-holding capacity of soils, which ultimately determines the depth of wetting and $CaCO_3$ deposition. Wind is critical in the formation of caliche in non-calcareous desert soils (particularly those in the eastern Mojave Desert), where windborne dusts and dissolved constituents in precipitation are considered to be the dominant sources of calcium for $CaCO_3$ deposition. The forested landscape and cool/wet environment of the late Pleistocene were likely important in the formation of caliche in the deserts of the American southwest (Marion et al. 1985; Schlesinger 1984). Analyses of the Eagle Mountain soils in the eastern Mojave Desert indicate at least two regimes of soil formation with a

major period of carbonate deposition at the Peak of the Wisconsin glaciation, and this $CaCO_3$ deposition is associated with inferred higher effective rainfall during this time (Schlesinger 1984).

We mapped soils within the Conservation Areas by accessing the Soil Survey Geographic (SSURGO) Database maintained by the Natural Resources Conservation Service, U.S. Department of Agriculture (http://soils.usda.gov/survey/geography/ssurgo).

Elevation

Mapping of elevation is critical in defining the altitudinal limits of desert tortoise habitat within each of the Conservation Areas. Desert tortoises have been recorded from elevations ranging from below sea level to 2,225 meters (7,300 feet) above mean sea level (msl) (Luckenbach 1982). Luckenbach (1982) reported that the most favorable habitat occurs at elevations of approximately 305 to 914 meters (1,000–3,000 feet) above msl, but more recent evidence from range-wide monitoring efforts indicates the desert tortoises are consistently documented above 914 meters (3,000 feet) (USFWS 2006a, 2008a). Protocol currently being developed by the USFWS includes a requirement for consideration of elevations between 300 to 1,525 meters (984 to 5,000 feet) above msl. We mapped elevation by accessing the USGS National Elevation Dataset.

Vegetation

The distribution of vegetation communities is an essential landscape variable that will be instrumental in describing desert tortoise habitat potential, particularly with respect to forage and shade resources. Typical characteristics of vegetation communities within desert tortoise habitat includes sparsely distributed perennials that allow for the development of abundant annual production and provide shade resources for tortoises as they forage and move between retreat sites. Desert tortoises typically occupy habitats dominated by creosote bush scrub at lower elevations, and blackbrush scrub and juniper woodland ecotones at higher elevations (Germano et al. 1994). Luckenbach (1982) reported that the most favorable habitats within California contained a high diversity of perennial plant species and high production of annual plant species. Desert tortoises are mostly distributed among four communities, including creosote scrub, cactus scrub, shadscale scrub, and Joshua Tree woodland, but are most commonly found in desert scrub vegetation communities dominated by creosote (Luckenbach 1982).

Appropriate vegetation communities support a diversity of forage plants, including annual and perennial herbs, forbs, and grasses. Within the western Mojave Desert, desert tortoises are known to select two-seeded milkvetch, Layne's milkvetch, Booth's evening primrose, rattlesnake weed, foothill deervetch, and desert wishbone (Jennings 1993). Additional preferred species include hill lotus, thorny skeleton plant, brittle spineflower, and lacy phacelia (Berry 1998); woolly plantain, and desert mallow (Burge and Bradley 1976); and desert dandelion, forget-me-nots, and bristly fiddleneck (M. Tuma, personal observation).

Finally, perennial shrubs provide important shade resources. Soil burrows are often excavated beneath perennial shrubs, which provide additional thermal protection. While on the surface outside of burrow or cave sites, tortoises often retreat under the cover of shrubs.

We mapped the vegetation communities within each of the Conservation Areas using GAP data. Determining habitat potential was further informed using a number of other layers to assist in the vegetation community mapping, including the National Hydrography Dataset layer to mask out playas and other waterbodies, and the National Wetlands Inventory to eliminate wetlands. The depth and hydric nature of soils were also used to define suitable habitat.

Precipitation

Precipitation is a critical aspect of desert tortoise habitat, and aspects of desert tortoise life history, including growth, fecundity, and survival, are precipitation dependent. Research indicates that season—particularly wet season versus dry season—is an important consideration when describing or assessing habitat potential with respect to precipitation. Wet (winter) season precipitation is especially crucial for the production of annual vegetation that provides forage for desert tortoises, whereas dry (summer) season precipitation provides drinking opportunities, which contributes substantially to desert tortoise survival. Thus, consideration of both wet and dry season precipitation must be considered to fully describe and assess potential desert tortoise habitat.

Luckenbach (1982) reported that the most favorable desert tortoise habitats within California included areas that received 50 to 200 mm of annual rainfall. Longshore et al. (2003) reported that annual biomass production was positively and highly correlated with the amount of wet season precipitation. The minimum amount of wet season precipitation that can result in annual production is 15 mm, as precipitation levels below this threshold can lead to annual germination failure (Beatley 1974). Levels of wet season precipitation and annual biomass production play a significant role in desert tortoise movement and activity patterns (Duda et al. 1999), growth (Medica et al. 1975), and survival (Longshore et al. 2003). Precipitation accumulations of more than 25 mm per each season (winter and summer) are considered "better" seasons for desert tortoise (Redlands Institute 2004).

Though dry season precipitation does not contribute to annual biomass production (Beatley 1974), observations indicate that summer rains may be critical for tortoise survivorship, particularly during drought years (Nagy and Medica 1986). Furthermore, dry season drinking opportunities are important for maintaining typical activity and growth during a year (Henen et al. 1998; Longshore et al. 2003).

We mapped wet season precipitation (November through February) to assess annual biomass production/foraging habitat potential. We also mapped dry season precipitation (June through September) to assess drinking habitat potential. We obtained precipitation data from the Oregon State University's Parameter-elevation Regressions on Independent Slopes Model (PRISM) Group. We compiled precipitation data, which are reported in hundredths of millimeters, for wet and dry seasons from 1990 through 2008. The dataset is somewhat coarse (2.5 arc-minute, or ~4 km) for the Mojave Desert region, but variability for these phenomena is minimal from a macro perspective. We estimated spatial resolution at one-half, or roughly 2 km. Values were interpolated at the analysis level.

2.4.2 Development and Testing of the Habitat Model

Habitat Model Development

Following mapping of the landscape variables, we delineated the range of appropriate desert tortoise habitats within each of the Conservation Areas accordingly:

<u>Geomorphology:</u> We masked areas with 10 meter DEM-derived slopes of greater than 45 degrees; therefore, the habitat model includes areas with slopes of 45 degrees and less.

<u>Elevation:</u> We masked areas greater in elevation than 1,525 meters and less than 300 meters; therefore, the habitat model includes elevations within this range.

<u>Soils:</u> We masked soils that are considered unsuitable for digging burrows such as clays and large areas of exposed bedrock; therefore, the habitat model includes friable soils such as loams, sands, and fine gravel.

Vegetation: We masked unsuitable vegetation communities and habitats that do not support appropriate desert tortoise habitat, such as developed lands, agricultural lands, croplands, forblands, hay/pasturelands, bedrock cliff and bedrock, marshland, playa, open water, and high-elevation communities; therefore, the habitat model includes appropriate desert scrub communities such as creosote bush scrub, Joshua tree woodland, Mojave-saltbush-allscale scrub, blackbrush, or juniper woodland ecotones.

Winter precipitation: We masked areas (based on 4 × 4-km grid cells) that over the 19-year period (1990–2008) average less than 25 mm of rainfall accumulations between November and February; therefore, the habitat model includes areas that averaged winter accumulations above 25 mm.

These five variables described what we consider minimally "good" desert tortoise habitat. We included in the model two additional variables—summer rain accumulations and caliche cave potential—that indicate "better" habitat. We mapped precipitation accumulations for each 4 × 4-km grid cell over the 19-year period and masked grids in which accumulations averaged less than 25 mm for the months of June through September. For caliche cave potential, we mapped areas containing soils that provided suitable conditions for the development of caliche overlapped with hydrological data to show possible locations of incised washes where caliche caves might be located. To determine where caliche layers might have exposed lenses for cave development, we created a flow accumulation layer using the 10-meter DEM to determine flow direction and subsequent accumulation. The flow accumulation layers show much smaller dendritic patterns, which are obvious on aerial imagery, than the current hydrology layers. These areas represent the highest probability of hydraulic channel incision and caliche cave potential. These mapped areas of "better" habitat were plotted over areas of "good" habitat to highlight areas within suitable habitat where tortoise survival is likely enhanced, particularly during periods of drought.

Testing the Habitat Model

We compared the areas of "good" and "better" habitat potential against existing tortoise occurrence data within each Conservation Area. The occurrence data were compiled from state heritage databases, plot and transect survey data, and survey reports. Only point locations of tortoises were considered in compiling the distribution data. Data sources included:

- California Natural Diversity Database
- Arizona BLM
- Nevada Department of Wildlife (NDOW) database Scientific Collections
- NPS NRPP Tortoise Monitoring Plots
- NPS NRPP Tortoise Triangular Transects
- Redlands Basedata geodatabase
- USFWS Line Distance Transect Data 2001-2005; 2007

Additionally, we tested the habitat model within the Gold Butte-Pakoon Conservation Area with field data collection. We established several treatment areas within the modeled habitat in the Conservation Area, within which we surveyed randomly generated plots (see Section 2.8 for full account of the sampling and survey methodologies). Within each treatment area, we compared tortoise densities between plots that sampled "good" and "better" habitat.

2.5 Population Assessment

To assess population trends within the Conservation Areas as required under the BASIC Task, population density estimates and reviews of these estimates were collected from published literature and unpublished

reports. Multiple survey techniques had been implemented during this time period; thus, published estimates of population density are based on data collected using different methodologies. We reviewed the literature to determine whether estimates derived from the disparate techniques could be reasonably compared and used to assess relative trends in desert tortoise population densities.

Information regarding the status of desert tortoise populations within each of the Conservation Areas were derived primarily from two datasets; Permanent Study Plots (PSPs) established by Kristin Berry (then with the BLM) starting in the 1970s and the Line Distance Sampling (LDS) transects established by the USFWS in 2001. In addition to these monitoring techniques, we reviewed various other methods that have been employed to detect or describe population trends, including triangular belt transect surveys, examination of total corrected sign data collected from plot and transect surveys, and previously conducted spatial analyses and population modeling based upon survey data. When reviewing the literature, we focused primarily on analyses of data that were collected at a localized scale within each of the Conservation Areas, but also considered analyses from the regional vicinity. We relied primarily on the review and analysis of the data collected from PSP monitoring studies provided by Tracy et al. (2004), and summary analyses of the LDS data provided by USFWS (2006, 2008b; 2009a).

2.6 THREATS ANALYSIS

To address the objectives of the Option 1 and 2 Tasks, we compiled a list of threats to desert tortoise from two primary sources, including Boarman (2002a) and the Draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise (USFWS 2008a: Appendix A). We mapped the locations of those threats that exhibit a spatial distribution within each Conservation Area, and developed in-depth literature reviews of each threat and their effect(s) on desert tortoise populations and habitat. The mapping effort was facilitated greatly through use of an existing threats geodatabase compiled by the Redlands Institute. Additional information about the occurrence and distribution of threats was procured during field studies within the Gold Butte-Pakoon Conservation Area and reconnaissance surveys within the Superior-Cronese Conservation Area. The methods employed during the field studies are described in Section 2.8 (Field Studies).

2.6.1 Threats Scoring

Since the HexSim model can analyze threats that occur either spatially or probabilistically, we characterized how the threats occurred (either spatially, probabilistically, or both) within the Conservation Areas. While characterizing the threats, we examined their effects, including habitat loss, habitat degradation, and direct mortality, among others. Many of the threats we examined contributed to multiple effects. For example, development of utility corridors could contribute to habitat loss, spread of invasive plants along the utility corridor, and increased human access to adjacent desert environments, as well as provide nesting habitat to ravens (a subsidized predator). As we compiled information and analyzed each threat, we considered these multiple pathways of effect, as well as the cumulative effects of threats, through development of a threats matrix.

Based upon the literature review and the spatial occurrence of each threat, we conducted a preliminary assessment of the importance of the threats to tortoise populations and their habitat, specific to each Conservation Area. In determining the relative importance of the threats within each of the Conservation Areas, we considered a cautionary statement from Boarman (2002a):

> The rating of relative importance of different threat factors is a difficult undertaking for several reasons. First, it is difficult to determine the cause of death of animals and it is even harder to determine how much decline is really attributable to the various indirect

> causes of mortality (e.g., habitat alteration).... Second, not enough is known about several potential threats to evaluate their absolute or relative impact.... Third, which mortality factors are functioning is very site specific.... Finally, as discussed above, factors that caused the declines (e.g., disease) may not be the same factors that are preventing recovery (e.g., genetic or demographic consequences of small populations, fragmentation, raven predation).

The following factors were considered when assessing the importance of each threat within the Conservation Areas:

1) Does the threat cause direct mortality to tortoises?
2) Does the threat contribute to habitat loss, degradation, or fragmentation?
3) Does the threat facilitate human access to areas supporting desert tortoise populations?
4) Does the threat contribute to or otherwise interact with other threats, resulting in cumulative effects?
5) For threats that can be characterized spatially, how widely distributed are they within the Conservation Areas? For those that can be characterized in a probabilistic manner, what is their probability for occurrence within the Conservation Areas?
6) Is the threat—or can the threat be—spatially distributed on or occur upon land in-holdings within the Conservation Areas that are outside of the management control of the BLM?
7) To what degree has the threat changed between 1990 and 2008?

Desert Tortoise Mortality

Most turtle species are characterized by a suite of life history traits, including slow growth and delayed sexual maturity, repeated reproduction (iteroparity), extended longevity without reproductive senescence, low fecundity, high nest mortality, and low juvenile mortality (Wilbur and Morin 1988; Congdon et al. 1993). Similarly, desert tortoises are long-lived organisms with delayed sexual maturity. Maximum lifespan has been estimated at 50 to 70 years (Germano 1992; 1994), and sexual maturity is attained in approximately 12 to 20 years when tortoises reach a size of approximately 208 mm (carapace length) (Turner and Berry 1984; Turner et al. 1986). Desert tortoises display relatively low fecundity, with females laying between one and eight eggs per clutch (with an average clutch size of 4.5), and up to three clutches deposited per year (Turner et al. 1986). Clutch size and number probably depend on female body size, water availability, and annual productivity of forage plants in the current and previous year (Turner et al. 1984, 1986; Henen 1997). Though there are no published data regarding the rate of nest success in desert tortoises, we expect that nest predation rates are high, similar to other turtle species. Though desert tortoises have likely traditionally experienced relatively low juvenile mortality rates, the recent spread and increase of common raven populations and their subsequent predation pressure on juvenile tortoises threatens to disrupt recruitment patterns substantially. Collectively these life history traits – as has been demonstrated with other long-lived turtles – limit the ability of populations to recover from demographic perturbations, making them extremely sensitive to high mortality rates in individuals (Brooks et al. 1991; Congdon et al. 1993; 1994). Life history traits that co-evolve with longevity limit the ability of turtle populations to recover from chronic increases in mortality (Congdon et al. 1993). Removal of desert tortoises can therefore severely and negatively affect the long-term viability of tortoise populations.

A variety of anthropogenic factors leads directly to the removal of individuals from tortoise populations, either through killing or collecting of tortoises. OHV use, military activities, and construction activities

may contribute to declines of tortoise populations by crushing individuals located above or belowground. Roads located in tortoise habitat contribute to road-killed tortoises and the collecting of tortoises as pets. Livestock grazing may result in the crushing of tortoises, and subsidized predators likely increase predation pressures on both juvenile and adult cohorts. We discuss in detail the specific effects of these threats and others in the Threats Analysis. We scored each threat for its effects on tortoise mortality according to the following scale:

0 = no effect

1 = mild effect

2 = moderate effect

3 = severe effect

Loss, Degradation, or Fragmentation of Desert Tortoise Habitat

Arguably the greatest threat faced by desert tortoises is loss of habitat. Desert tortoises depend on high quality habitat for forage, burrow construction, and reproduction activities; when habitat is lost or severely degraded, tortoises can no longer inhabit the area. Desert tortoise habitat can be lost directly through human activities, such as conversion of tortoise habitat to agricultural lands or human developments, or indirectly through activities that lead to habitat degradation, such as livestock grazing, off-road vehicle use, and the introduction of nonnative, invasive plant species. Cumulative effects of habitat loss and degradation can lead to habitat fragmentation, whereby populations of tortoises are restricted to small "islands" of suitable habitat surrounded by developed or degraded habitat.

While loss of habitat to agriculture or development is easy to quantify, the effects of habitat degradation are less obvious. Nonetheless, a body of data indicates that habitat degradation, which results primarily in changes to vegetation communities, is a real threat to tortoise survival. Grazing of livestock contributes to compaction of soils and trampling of vegetation, and perhaps most important, causes significant and detrimental changes in the composition and structure of the plant and animal communities (Berry 1978; Webb and Stielstra 1979; Nicholson and Humphreys 1981; Brooks 1995). Habitat degradation that results in the depletion of native forage species contributes to the invasion of exotic annual and perennial species that are less nutritious to tortoises. The proliferation of exotic plant species also results in higher frequencies and intensities of anthropogenic fire, which further degrades native plant communities that have evolved in fire-free ecosystems (USFWS 1994). Military and off-road vehicle activities also destroy vegetation used by tortoises for food or cover, and allow for the invasion of exotic species.

Loss or degradation of habitat also leads to fragmentation of habitat into isolated patches. Isolated patches may be too small to sustain a viable breeding population, and not connected enough to allow movement of individuals between patches. Restrictions in carrying capacity within patches and gene flow between patches could ultimately lead to local extirpations of populations within habitat patches. Together, reductions in population size and genetic diversity, along with degradation of habitat, may lead to the inability of local populations to respond to stochastic perturbations or disease incidence (see Collinge 2009).

We discuss in detail the specific effects of these threats and others in the Threats Analysis. We scored each threat for its effects on the loss, degradation, and fragmentation of desert tortoise habitat according to the following scale:

0 = no effect

1 = mild effect

2 = moderate effect

3 = severe effect

Facilitation of Human Access to Desert Environments

Since most threats to desert tortoises (both those that contribute to desert tortoise mortality and those that contribute to the loss, degradation, and fragmentation of desert tortoise habitat) originate from anthropogenic sources and actions, threats that facilitate human access to desert environments inhabited by tortoises likely contribute to an increase in mortality and habitat effects. We scored each threat for its effects in providing human access to desert environments according to the following scale:

0 = no effect

1 = mild effect

2 = moderate effect

3 = severe effect

Cumulative Effects

Many of the threats we considered likely interact in a cumulative manner, particularly in areas where desert tortoises or their habitat experience multiple threats or stressors in time or space. The manner in which multiple threats interact is poorly understood in ecological systems, though three possibilities may result: 1) threats may be additive, whereby the effects of each threat accumulate in an additive manner, i.e., the effects of two or more threats are equal to the sum of their individual effects; 2) threats may be antagonistic, whereby their effects interact to produce a lesser effect than the sum of their individual effects; or 3) threats may be synergistic, whereby the effects of the threats interact to produce an effect that is greater than the sum of their individual effects (Folt et al. 1999; Crain et al. 2008). In a review of 171 studies examining the effects of two or more threats, Crain et al. (2008) determined that at the population level, most threats acted in a synergistic manner. Therefore for the current investigation of the effects of threats to desert tortoise populations, we assumed that two or more threats occurring together in time or space interacted synergistically. For example, roads, railroads, and linear utility corridors are often located along right-of-way corridors. Each of these linear features act individually to fragment habitat, but we assumed that accumulations of these features in space would result in a synergistic effect.

Perhaps a more important consideration of the interactive nature of threats is the manner in which one threat may cause another threat to occur with greater probability. For example, threats that cause soil disturbance (e.g., roads, OHV use, livestock grazing, etc.) likely result in a greater probability of the threat of invasive plants. Likewise, certain anthropogenic features and activities (urbanized areas, anthropogenic water sources, agricultural practices, etc.) increase the probability of occurrence of another threat—subsidized predators.

We scored the interactive or cumulative effects of threats by totaling the number of interactions each threat had with others, including those that occurred together in time or space or those that increased the probability of occurrence of other threats. Based on the total of interactions, we assigned the following scores:

1 = 1–5 interactions

2 = 6–10 interactions

3 = 11–15 interactions

4 = >15 interactions

Spatial and Temporal Distributions of Threats

We scored the distribution, probability, or severity of the threats within each Conservation Area by assigning a variable between 0 and 1 based upon the percent area within the Conservation Areas of spatially distributed threats and the probability of occurrence of probabilistic threats. Larger scores were assigned to threats that were more widely distributed, occurred at a higher probability, or caused a more severe effect (based on both spatial and probabilistic distributions) within the Conservation Areas. The scores were based upon 1) the results of the threats literature review, which accounted for the actions, characteristics, and known history of each threat, and 2) the threats mapping, which detailed the distributions and probabilities for their occurrence across the landscape.

We scored the maximum potential for occurrence of selected threats on land in-holdings within the Conservation Areas by the proportion of the area of maximum area of occurrence of the threats on land in-holdings within each Conservation Area. We only scored selected threats that change landscapes dramatically, including urbanization, mining, agriculture, and military activities. When scoring these threats, we considered the current ownership and land use, conservation status, and landform characteristics within the in-holdings in determining their potential for occurrence. Land in-holdings that contained hilly or mountainous terrain were considered appropriate for mining, whereas those containing flat or bajada terrain were considered appropriate for urbanization, agricultural practices, and (on Department of Defense in-holdings within the Superior-Cronese Conservation Area) military activities. Following this analysis, the threats were scored by the percent area of in-holding within the Conservation Area that they could maximally occur in the future. For example, if a threat could maximally occur on land in-holdings that accounted for 15 percent of the area within the Conservation Area, the threat would be assigned an in-holding score ($\hat{I}_{max}$) of 0.15.

Change and Trajectories of Threats

We scored the degree of change of selected threats between 1990 and 2008 by examining the change in area attributed to the threat using remote sensing. In doing so, we selected only those threats that leave a signature on the landscape that can be detected through remote sensing, including development of urban areas, roads, utilities, mines, landfills, OHV use, and livestock grazing. Examining the degree of change these threats caused during the period of study allowed for a consideration of both the magnitude and the growth trajectory of each threat within each Conservation Area. The degree of change variable (C_t) was calculated using the following equation:

C_t = (acres of change detected between 2001-2008 / acres of change detected between 1990-2001) x % area of change (total) detected within the Conservation Area

Threats Ranking

Following the assignment of the scores, we ranked the threats according to the following formula:

$$S_A = ((M_t \times 3) + (H_t \times 2) + A_t + I_t) \times (d + \hat{I}_{max} + C_t)$$

Where:

M_t = Score of the threat in causing mortality to tortoises*

H_t = Score of the threat in causing habitat loss, fragmentation, or degradation†

A_t = Score of the threat in allowing human access to desert areas inhabited by tortoises

I_t = Interactions/cumulative effects score

d = Distribution/probability/severity variable

$\hat{I}_{max}$ = Maximum occurrence on land in-holdings variable

C_t = Degree of change variable

S_A = Adjusted score

*Because of the severe effect of mortality on desert tortoise populations, we weighted this effect relative to others by multiplying its effect score by three (3).

†Because of the strong negative effect of habitat loss, degradation, and fragmentation on desert tortoise populations, we weighted this effect relative to others by multiplying its effect score by two (2).

The threats within each Conservation Area were ranked according to the adjusted score of each threat.

2.7 Management Plan Review

To address an additional objective of the Option 1 Task, we reviewed all land management documents for each Conservation Area during the period from 1994 to 2008. This included a thorough review of the land management plans, summarizing: (1) specific management recommendations pertaining to desert tortoises and their threats; (2) changes in the direction of management during the period under question; and (3) an assessment of the BLM's success in implementing the management recommendations. Additionally, we examined the level and extent of law enforcement patrols during the period under question, summarizing any changes.

Finally, to address the objectives of the Option 3 Task, we evaluated the status of the Specific Management Actions identified in Appendix F of the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a) for each of the Conservation Areas. We used the results of the preliminary threats prioritization to identify and prioritize which of the Management Actions should be considered for implementation by the BLM.

2.8 Field Studies

Pursuant to collecting additional data in support of developing the HexSim model, field studies were initiated within the Gold Butte-Pakoon Conservation Area in September 2009. The goals of the field data collection were to 1) determine the occurrence and distribution of threats, including disease incidence; 2) test the preliminary habitat suitability model; and 3) procure additional data regarding demographic, ecological, and life history characteristics of desert tortoises, including population size and structure, home range and movement patterns, habitat use, and survivorship. The following is a description of the sampling design and field methods employed in the data collection effort.

2.8.1 Sampling Design

We used a stratified random sampling design to examine the severity and distribution of threats and their effects on desert tortoise demography and disease status. We selected four treatment areas to examine the effects of particular threats, including urbanization, OHV use, grazing, and fire. We selected a fifth treatment area in a relatively unimpacted area for comparison purposes. We established the treatment areas in "good" or "better" habitat in the preliminary habitat suitability model. We initially delineated the

boundaries of the individual treatment areas due to their proximity to known mapped threats, which we later modified based upon on-the-ground conditions as observed during the field effort. We established a minimum of three randomly placed 1 x 1-km plots within each of the treatment areas to sample for tortoises and threats. We avoided previous study plots to the extent possible. If a randomly generated plot fell within the boundaries of a previous study plot (such as a Permanent Study Plot), we randomly generated a new plot. A map showing the final arrangement of treatment areas (n=5) and plot locations (n=17) is presented in Figure 3. Descriptions of the treatment areas are provided below.

Urban Treatment Area

The Urban Treatment Area is located on the Virgin Slope in the northwestern portion of the Conservation Area, just outside of the city of Mesquite and the community of Bunkerville (Figure 3). The limits of this treatment area were established to include modeled desert tortoise habitat along the Conservation Area boundary near these urbanized areas, and extending to a distance of 2 km from the boundary. Trash dumping is a prominent activity within the treatment area. Three 1 x 1-km plots were randomly established within the treatment area. The treatment area is generally characterized by the gently sloping, northeast facing, mid- to lower-level of the Virgin Slope bajada. Numerous ephemeral washes drain the bajada, with degree of wash incision increasing in upslope locations. Soils are generally characterized by unconsolidated alluvium within washes, well-developed desert pavement on ridges between washes, and good development of cryptobiotic soils. The vegetation community in the treatment area is dominated by creosote succulent scrub. Detailed descriptions of the geology, hydrography, soils, vegetation community, flora, and fauna within each plot are presented in Appendix A.

OHV Treatment Area

The OHV Treatment Area is situated within the Wechech Basin in the vicinity of Whitney Pocket in the west-central portion of the Conservation Area (Figure 3). The limits of this treatment area were established to include modeled desert tortoise habitat in an area characterized by frequent OHV use. The Whitney Pocket vicinity is characterized by picturesque geologic formations and cultural resources, and is a popular destination for campers, sight-seers, and OHV users. Camping and OHV use are prominent land uses in the treatment area. Three 1 x 1-km plots were randomly established within the treatment area. The treatment area is generally characterized by a diversity of smaller landforms (hills, ridges, and geologic outcrops) distributed within the Wechech Basin. Deeply incised washes and canyons characterize the hillsides, whereas braided and dendritic washes characterize the valley floor. Soils include sandstone, limestone, and gypsum rock outcrops on hills and ridges, and alluvial deposits on the valley floor. Vegetation communities are diverse in the treatment area, and include creosote scrub, with co-dominants or other dominants that include blackbrush, burrobush, yucca, and ephedra. Detailed descriptions of the geology, hydrography, soils, vegetation community, flora, and fauna within each plot are presented in Appendix A.

Fire Treatment Area

The Fire Treatment Area is located within the Pakoon Basin in the northeastern portion of the Conservation Area (Figure 3). The limits of this treatment area were established to include modeled desert tortoise habitat that had burned by wildfire. This area has been characterized by numerous wildfire events since the desert tortoise was listed, detailed in Table 1.

Table 1. Summary of Wildfire Events Within the Fire Treatment Area During the Period of Study (1990-present).

Fire	Year	Fire	Year
Cedar Wash	1993	Black Canyon 2	2001
Cottonwood	1993	Grand	2001
Cottonwood	1994	Brumley	2005
Wayne	1994	Cedar Wash	2005
Airstrip	1995	Cow	2005
Big Hole	1995	Jacob	2005
Jacob Well	1995	Tweedy Complex	2005
Mud	1995	Jacob	2006
Tasteful	1995	Pocket Complex	2006

Livestock grazing is a prominent land use in the treatment area. Three 1 x 1-km plots were randomly established within the treatment area. The treatment area is generally characterized by washes and adjacent terraces within the Pakoon Basin. Some of the washes occur within deeply incised canyons. Soils within the treatment area consist of gravelly and cobbly soils derived from basalt bedrock. Because large areas over the treatment area have burned several times, original desert scrub vegetation communities are in post-fire succession, often dominated by nonnative annuals. Detailed descriptions of the geology, hydrography, soils, vegetation community, flora, and fauna within each plot are presented in Appendix A.

Grazing Treatment Area

The Grazing Treatment Area is located within the Pakoon Basin in the southeastern portion of the Conservation Area (Figure 3). The limits of this treatment area were established to include modeled desert tortoise habitat in areas that received intensive grazing pressure. Evidence of ranching activities is prevalent throughout the treatment area, and livestock grazing is the prominent land use in the treatment area. Three 1x1 km plots were randomly established within the treatment area. The treatment area is generally characterized by washes and adjacent terraces and mesas within the Pakoon Basin. Soils within the treatment area consist of gravelly and cobbly alluvial soils. Cryptobiotic soils are patchy in distribution but have been substantially disturbed by the actions of intensive cattle grazing. The dominant vegetation community within the treatment area is creosote-bursage scrub. Detailed descriptions of the geology, hydrography, soils, vegetation community, flora, and fauna within each plot are presented in Appendix A.

Control Treatment Area

The Control Treatment Area is located on the Virgin Slope in the northwestern portion of the Conservation Area (Figure 3). The limits of this treatment area were established to include modeled desert tortoise habitat within an area that was relatively unimpacted by land use and threats characteristic of the other treatment areas. This treatment area is located upslope from the Urban Treatment Area and set at a distance of at least 1 km from the Urban Treatment Area boundary. Prominent land uses within the treatment area include grazing and OHV use, but at considerably lower intensities than observed in other treatment areas. Three 1 x 1-km plots were randomly established within the treatment area. The treatment area is generally characterized by the gently sloping, northeast facing, mid to upper portion of the Virgin Slope bajada. Numerous ephemeral washes drain the bajada, with degree of wash incision increasing in

upslope locations. Soils are generally characterized by unconsolidated alluvium within washes, well-developed desert pavement on ridges between washes, and good development of cryptobiotic soils. The vegetation community in the treatment area is dominated by creosote succulent scrub. Detailed descriptions of the geology, hydrography, soils, vegetation community, flora, and fauna within each plot are presented in Appendix A.

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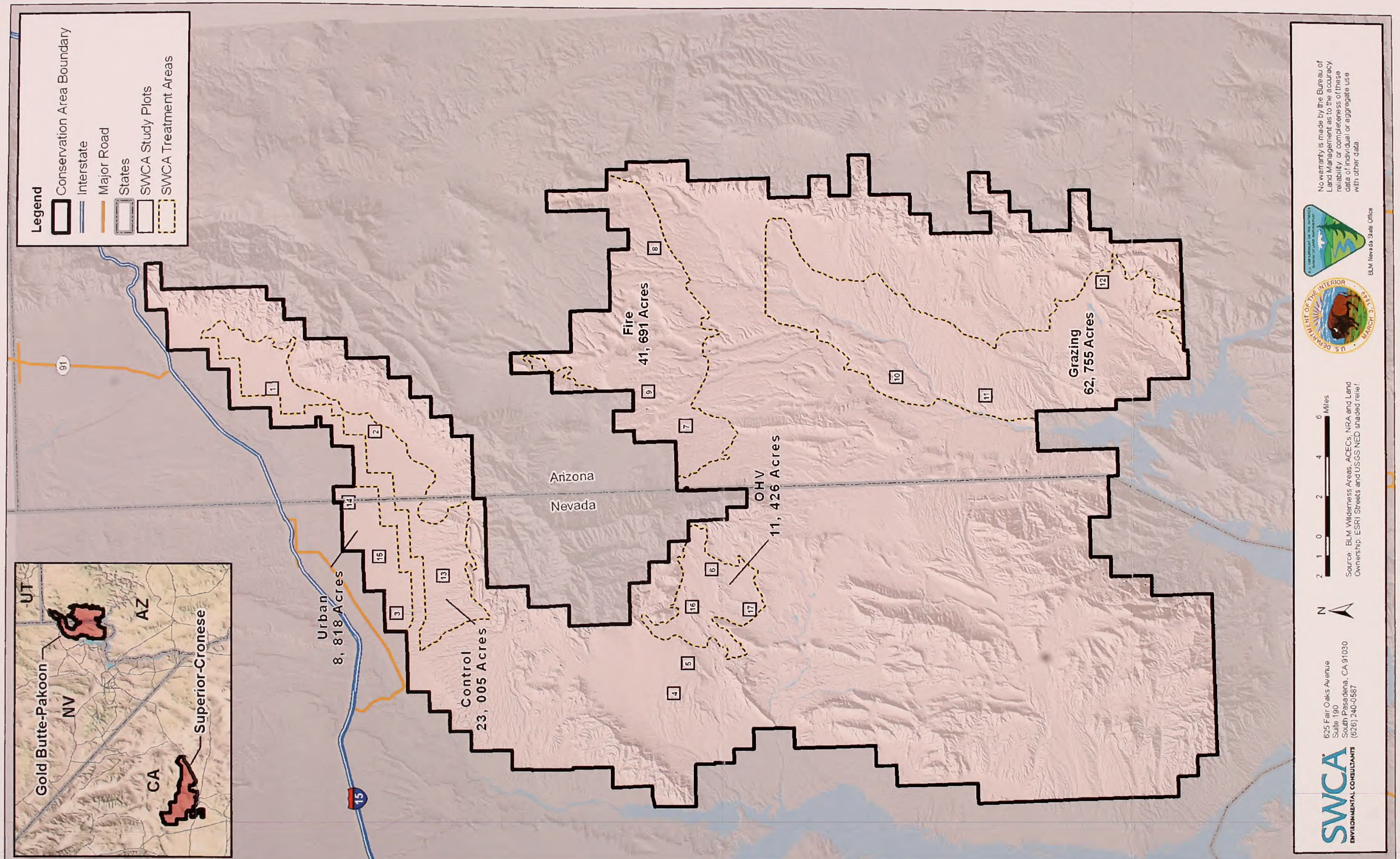

Figure 3. Locations of Treatment Areas and Sampled Plots within the Gold Butte-Pakoon Conservation Area

2.8.2 Data Collection Methods

Prior to entering the field, we developed field forms to facilitate standardization of the data collection. The forms included Plot Characterization, Threats Observation, and Daily Journal forms. Using these forms, we detailed each plot's physical and biological characteristics and the occurrence, distribution, and severity of threats on each plot. We characterized the topographic, hydrological, soils, caliche cave development, and vegetation community attributes for each plot, and generated a full plant and wildlife species list. We recorded a panoramic photograph from the northwest corner of each plot. During survey transects (described below) we recorded data regarding the type and number (or relative abundance or presence/absence) of threats observed on each plot, including evidence of livestock grazing, fire, OHV use (single- and double-track trails), roads (paved, graded, or ungraded), trash (dumps, isolates, and windblown), invasive plants (*Bromus*, *Schismus*, mustard, and others), subsidized predators (coyotes, ravens, and dogs), and evidence of human use of the area (campsites, people, and other evidence).

We surveyed each plot using transects spaced at 10 meters. Biologists with experience in surveying for desert tortoises and familiarity with desert tortoise biology and behaviors performed the surveys. We made an effort to search for and capture every tortoise on each plot. When a tortoise was discovered within a burrow or cave, we extracted the tortoise passively using a "tapping" technique (Medica et al. 1986). Tortoises were handled according to USFWS-approved guidelines (Desert Tortoise Council 1999; Berry and Christopher 2001), which included the use of latex gloves during handling and use of a 10-percent bleach solution to clean equipment following processing of each tortoise. Tortoises were captured and handled only when the ambient air temperature was 95° F or cooler. We processed captured tortoises in a shady area a short distance from their point of capture. During processing, we recorded shell measurements (maximum midline carapace length [MCL], maximum shell height, and maximum shell width [between the fourth and fifth marginal scutes]) and mass in grams. We uniquely marked each tortoise using a modified Cagle (1939) shell numbering system. We permanently marked each tortoise by filing notches in the marginal scutes, and glued a floy tag with the identification number to the 4th costal scute using clear epoxy. A portion of the captured tortoises—up to 15 tortoises per treatment area—were fitted with radiotransmitters (ATS, Series R2200; Holohil, RI-2B). The transmitters were attached using a technique described in (Boarman et al. 1998). We limited processing time to 30 minutes per tortoise. Following processing, we released the tortoises at their point of capture. We tracked telemetered tortoises within 24 hours of their capture to verify that they had retreated to a cover site, and to determine that their transmitters were functional. Following this initial tracking visit, we tracked tortoises on a monthly basis, recording their behaviors and location information. We recorded aspects of cover sites used by tortoises on a standardized data collection form and photographed them. Additionally, we placed a permanent, inconspicuous marker at each cover site.

Fieldwork was performed under USFWS 10(A)1(a) Recovery Permit #195280-0, NDOW Scientific Collection Permit #S32293, and Arizona Game and Fish Department (AZGFD) Scientific Collecting Permit #SP551757. Copies of the permits are provided in Appendix B.

2.8.3 Data Analysis Methods

Testing the Habitat Model

We tested the habitat model using both quantitative and qualitative techniques. We determined the number of tortoises captured or observed on plots within habitat modeled as either "Good" or "Better" and compared the observed distribution of tortoises against the proportion of each habitat mapped within the plots (expected distribution) using the Chi-square test statistic. In a qualitative analysis, we described

caliche cave development on each plot, and compared the character of cave development to the "Good" vs. "Better" habitat model.

Population Assessment

Tortoise populations within the Gold Butte-Pakoon Conservation Area were separated into subpopulations according to geographic areas supporting desert tortoise habitat (according to the model) and included: 1) the Virgin Slope (urban and control treatment areas), 2) the Wechech Basin (OHV treatment area), and 3) the Pakoon Basin (fire and grazing treatment areas). The treatment areas within these geographic locations were combined, and the numbers of tortoises observed on plots within the combined treatment areas were averaged to estimate the density of tortoises (per square kilometer) within each of the three geographic areas.

Threats Assessment

Threats data collected on plots within each of the treatment areas were analyzed for their presence and level of severity within each plot. The threats analysis included a combination of quantitative and qualitative descriptions of the threats, as described below.

Grazing

Evidence of grazing on the plots consisted of dung, tracks, trails, terracettes, wallows, carcasses, live grazing animals, and grazing infrastructure (including watering troughs, tater tanks, water pipelines, fencing, and corrals). Grazing data were characterized qualitatively for each plot.

Fire

Evidence of fire on the plots consisted of burned or charred vegetation. Fire data were characterized qualitatively for each plot.

OHV

Evidence of OHV use on plots included single-track and double-track trails. Trail data were characterized quantitatively for each plot. The number of times a trail was crossed on transects allowed for an analysis of the probability of encountering trails per square kilometer within the treatment areas.

Roads

Evidence of roads on plots included the presence of ungraded dirt roads, graded dirt roads, and paved roads. Road data were characterized quantitatively for each plot. The number of times a road was crossed on transects allowed for an analysis of the probability of encountering roads per square kilometer within the treatment areas.

Trash

Evidence of trash on plots included isolated pieces of trash, windblown trash, trash dumps, and trash scatters. Trash data were characterized quantitatively for each plot. The number of times trash was crossed on transects allowed for an analysis of the probability of encountering trash per square kilometer within the treatment areas.

Invasive Plants

Evidence of invasive plants on the plots consisted of the presence of several nonnative annual species. Invasive plant data were characterized qualitatively for each plot.

Subsidized Predators

Evidence of subsidized predators on plots included the presence of several predatory species. Subsidized predator data were characterized quantitatively for each plot. The number of times a desert tortoise predator was crossed on transects allowed for an analysis of the probability of encountering predators per square kilometer within the treatment areas. For coyotes, sign was counted rather than individual animals to assess the relative densities of these predators.

Human Presence

Evidence of human presence on plots included campsites, observations of people on the plot, and other evidence of human presence on the plot, including rock cairns, survey or boundary markers, bullet casing scatters indicative of shooting, etc. Human presence data were characterized quantitatively for each plot. The number of times evidence of human presence was crossed on transects allowed for an analysis of the probability of encountering evidence of human presence per square kilometer within the treatment areas.

3. RESULTS

3.1 HABITAT MODEL

"Good" habitat was modeled for each of the Conservation Areas by mapping areas that included suitable limits of elevation, slope, friable soils, vegetation communities, and minimum winter precipitation accumulations. Individual maps depicting the distribution of these landscape variables are depicted for each Conservation Area in Figures C-1 through C-10 in Appendix C. "Better" habitat was modeled for each of the Conservation Areas by mapping areas that received summer rains accumulations of more than 25 mm per year between 1990 and 2008 (Appendix C, Figures C-11 and C-12) and areas that contained the potential for caliche cave development (Appendix C, Figures C-13 and C-14). These two variables likely provide enhanced survivorship of tortoises, thereby providing "better" habitat within areas of "good" habitat. Models of "good" and "better" habitats within each of the Conservation Areas, with known desert tortoise occurrences plotted for comparison, are presented in Figures 4 and 5.

Test of the Habitat Model

The majority of known desert tortoise occurrences were included within areas that we included as suitable habitat in the model. Within the Gold Butte-Pakoon Conservation Area, 228 (95.4%) of 239 tortoise occurrences were included in the habitat model (Figure 4); within the Superior-Cronese Conservation Area, 765 (99.7%) of 767 tortoise occurrences were included in the habitat model (Figure 5).

Modeled habitat within the Gold Butte-Pakoon Conservation Area plots included areas mapped as both "good" and better" habitat. Table 2 presents the area of "good" and "better" habitat within each plot, as well as the distribution of tortoises between soil burrows and caliche caves for each plot.

Table 2. Distribution of Modeled Habitat and Live Tortoise Observations Within Each Study Plot.

Plot	"Good" Habitat (km^2)	Number of Tortoises in "Good" Habitat	"Better" Habitat (km^2)	Number of Tortoises in "Better" Habitat
1	0	0	1.00	6
2	0	0	1.00	2
3	0	0	1.00	7
4	0	0	1.00	0
5	0	0	1.00	0
6	0.03	0	0.97	2
7	0.03	0	0.97	0
8	0.99	0	0	0
9	0.91	0	0	0
10	1.00	0	0	0
11	0.05	0	0.95	0
12	0.01	0	0.97	0
13	0	0	1.00	2
14	0.28	6	0.72	7
15	0	0	1.00	2
16	0.26	0	0.74	0
17	0.84	1	0.16	0
Total	4.40	3	12.48	32
%	26	8.6	74	91.4

Chi-square goodness of fit testing revealed that the observed distribution of tortoises on "better" habitat (n=32) was significantly different than the expected distribution of tortoises on "better" habitat (n=26) based upon the area of "better" habitat within the surveyed plots ($\chi^2 = 5.3846$; df = 1; $p < 0.05$). Thus, tortoises appear to either prefer "better" habitat, or perhaps survivorship is enhanced in areas of "better" habitat.

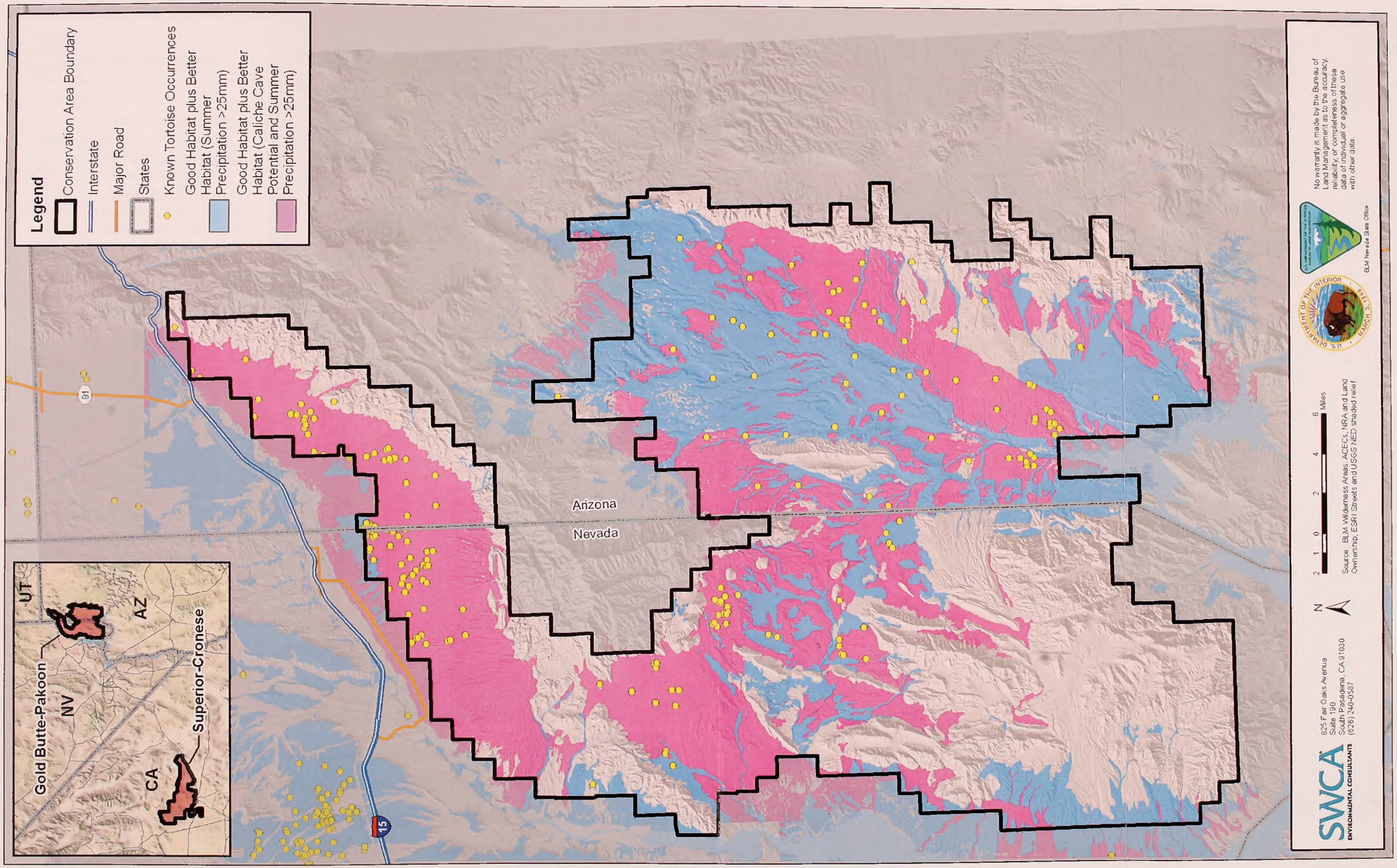

Figure 4. Habitat Model for the Gold Butte-Pakoon Conservation Area with Known Desert Tortoise Occurrences

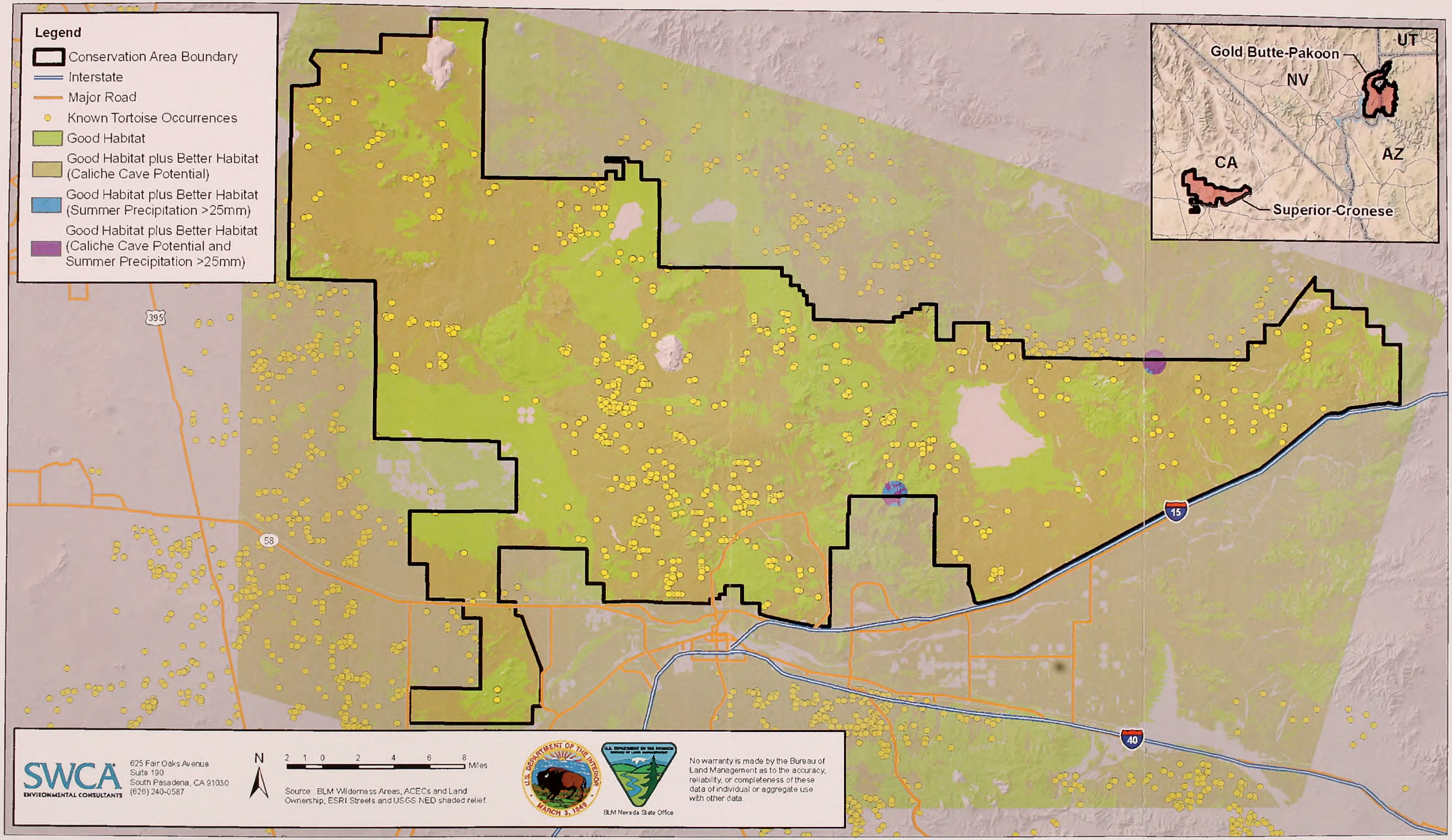

Figure 5. Habitat Model for the Superior-Cronese Conservation Area with Known Desert Tortoise Occurrences

3.2 POPULATION ASSESSMENT

The following discussion outlines the history of desert tortoise population monitoring techniques focusing primarily on the PSP and LDS methods. The following review of assessments of tortoise population trends within the Conservation Areas is based upon analyses within published literature and unpublished reports on data that were collected between 1990 and 2008 by a variety of researchers and consultants using a variety of techniques.

The various survey techniques used to collect data for estimating population densities, as well as inconsistent use of these techniques over spatial and temporal scales, made accurately assessing the status and trends of desert tortoise populations within the Conservation Areas challenging. In particular, plot studies, which provide fairly complete population data for small, localized areas that are intensively surveyed, are difficult to compare to transect surveys, which consist of sampling efforts applied over large areas and provide imprecise estimates of tortoise abundance over broad regions. In addition, without robust and reliable baseline data that neither plot nor transect surveys have provided, determining the magnitude or significance of perceived population trends is not feasible.

3.2.1 Implemented Monitoring Techniques

Permanent Study Plots

In the early 1970s, Kristin Berry at the BLM established a system of long-term PSPs (Berry 1984; USFWS 1994a) to conduct research that would address concerns about observed declines in desert tortoise populations throughout their range. The PSPs were established primarily on public lands in California in the 1970s and—approximately 10 years later—in Nevada, Arizona, and Utah (Tracy et al. 2004). Until recently, research based on data collected from PSPs was the primary source of information regarding the status and trends of desert tortoise populations. Data collected from the PSPs were intended to be used to provide information in support of the development of management and conservation strategies (Berry 1986a), and were used in part as a basis for listing of the desert tortoise recovery recommendations in the 1994 Recovery Plan (USFWS 1994a).

The PSPs were initiated with the objectives of obtaining information on desert tortoise population demography and trends across the species' range using mark-recapture techniques and other methods (Berry 1984). Specific population data collected on the PSPs included density, size-age class structure, sex ratios and numbers of breeding females, recruitment of juveniles, and causes of death and mortality rates (Berry and Medica 1995).

The methodology and validity of the interpretations of data collected from the PSPs has been criticized (Corn 1994; Tracy et al. 2004). In particular, the data collected using the PSP method is limited in value for statistical assessments of population status and long-term trends in population density. This is primarily due to the establishment of PSPs at non-random locations without consideration of hypothesis testing. Because PSPs were not randomly placed across the landscape but were purposefully positioned within areas known to have higher occurrences of tortoises and within representative tortoise habitat, extrapolations to other habitats were not possible (Tracy et al. 2004). Since the PSPs were not developed to address specific hypotheses, assessing factors that may be driving changes in tortoise populations is not feasible (Tracy et al. 2004). In addition, detectability was never measured, which limits the ability to make temporal comparisons of status and trends (Tracy et al. 2004). Tracy et al. (2004) also argued that sampling has been inconsistent, with no regular survey intervals. This problem is further compounded by follow-up surveys often being conducted on only small subsets of established PSPs per year, and the fact that several PSPs have been surveyed only once or twice.

Line Distance Sampling Transects

Distance sampling is a population-monitoring technique that allows researchers to account for differences in detectability at variable distances, among different species, and in different habitat types (Buckland et al. 2001). This is important because desert tortoises are a cryptic species that often avoids detection, especially by inexperienced biologists. Distance-sampling data are used to estimate population density by fitting a detection function to the detection probability histogram for the species being modeled using the computer program DISTANCE (Buckland et al. 2001; Thomas et al. 2006). LDS uses the distances objects are found from a transect's centerline to estimate a detection function. The detection func-tion provides an estimate of the number of objects found on a transect, and by assuming that all objects at the center of the transect (on or very near the line) are found, provides an estimate, with confidence limits, of the total population size. Distance sampling relies on three assumptions for producing reliable density estimates: 1) all objects on the line or point are detected with certainty, 2) objects are detected at their initial location, and 3) distance measurements from the survey line to the detected object are exact (Buckland et al. 2001). This new methodology improved estimates of population size and density over the PSP methodology, and was initiated by the USFWS in 2001 to monitor desert tortoise populations range-wide (Tracy et al. 2004; USFWS 2006a). Following the shift to LDS methodology in 2001, USFWS desert tortoise monitoring efforts were conducted by positioning LDS transects randomly across the landscape using specific habitat strata as a criteria to identify areas of sampling interest (USFWS 2007). The primary objective of the LDS monitoring program was to determine whether recovery goals were being met, specifically a 1-percent increase in population over a 25-year period.

Due to considerable variability in the data collected between the sampling years (due to changes in survey technique and inconsistent funding), the USFWS modified the program's methodology and manner of data analysis in 2004 to address the sources of variability. Thus, interpretations of the data from the LDS surveys are complicated by variability in the data as a result of problematic methodology and then by changes in field techniques from one field season to the next. In addition, problems with interpretations of LDS data are further compounded because the distance sampling assumption that all objects along the line are detected may not be accurate. Desert tortoises spend a considerable portion of time belowground, and detection is largely influenced by the experience level of the surveyor; if there is not strict control of surveyor experience and expertise, differences in observation success among surveyors results in negation of the principal assumption. Another issue that limits the value of LDS data in this specific case is the reduced sampling in 2002 and 2003, compared with other years. Due to the short data collection period, data variability, and changes in sampling methods over the first five years, the data collected from 2001 to 2005 cannot be compared with data collected after 2005. Therefore, the USFWS used the data collected between 2001 and 2005 as a baseline for continued monitoring efforts or to detect catastrophic changes in population parameters (USFWS 2006a).

Triangular Belt Transects

Beginning in the 1970s the BLM used triangular belt transect methods to assess the relative abundance of desert tortoise populations. This technique involves a single observer walking an equilateral triangle measuring 0.5 mile on a side. The surveyor walks a total transect length of 1.5 miles, making observations within an "observation belt" 33 feet in width around the entire triangle, recording tortoises and their sign (Berry et al. 1984). Similar to LDS transects, triangular belt transects are widely dispersed and distributed randomly across the landscape. Analyses of triangular belt transects are dependent on the same three assumptions as analyses of LDS transect methods, and therefore suffer similar difficulties.

Total Corrected Sign Counts

The total corrected sign counts method estimates population parameters from observed desert tortoise sign (scat, tracks, etc.) using information about sign data from areas with known population parameters.

Desert tortoise sign is counted during transect surveys, and the data is corrected using a multiplier calculated from sign counts in an area of known tortoise density to estimate tortoise density within the survey area. This method was used by the BLM on data collected from PSPs and triangular belt transects as early as the 1970s. Results using this method depict only relative patterns of tortoise occurrence and do not estimate population density or relative abundance (Tracy et al. 2004).

3.2.2 Summary of Population Trends

Gold Butte-Pakoon Conservation Area

Three PSPs are located within the Gold Butte-Pakoon Conservation Area, including the Gold Butte PSP in Nevada, the Pakoon Basin PSP in Arizona, and the Virgin Slope PSP in Arizona. Suitable sample sizes were obtained from the Gold Butte PSP during surveys in 1986, 1990, and 1994. Substantially fewer tortoises were found on the Gold Butte PSP in 1990 (n=32) than 1986 (n=88) (SWCA 1990). Large numbers of carcasses found at the site have been interpreted as a relatively high mortality rate (estimated at approximately 22.1%) between the sampling periods (Medica 1992). The Desert Tortoise Recovery Plan Assessment Committee (DTRPAC) found no statistically significant trends in density over time, citing overlapping 95-percent confidence intervals for density estimates on the Gold Butte PSP among all years included in analyses (Tracy et al. 2004). Researchers conducted surveys on the Virgin Slope PSP during 1992 and 1997, and conducted LDS surveys in addition to surveys on the Virgin Slope PSP in 2003. Surveys on the Virgin Slope PSP detected 15 tortoises in 1992 and 41 tortoises in 1997. In 2003, only nine tortoises were observed; one of these individuals exhibited clinical signs of URTD. Researchers attributed the apparent 29-percent decline of the tortoises on the plot since 1997 to disease (Goodlett and Woodman 2003). The Pakoon Basin PSP was surveyed once in 1991 (Bashor 1991) but was not resurveyed.

Desert tortoise population trends in the Gold Butte-Pakoon Conservation Area are limited in extent, and analyses of data collected at PSPs in the neighboring Northeast Mojave Recovery Unit provide additional information on population trends in the region. Data collected from two PSPs (Beaver Dam Exclosure and Littlefield) situated within the Beaver Dam Slope DWMA located northwest and adjacent to the Gold Butte-Pakoon Conservation Area provided evidence of high rates of desert tortoise mortality in the region. The Beaver Dam Exclosure PSP was surveyed in 1980, 1989, 1996, and 2001. In 2001, the number of live tortoises found (n=6) (Walker and Woodman 2002) was notably smaller than in previous years (n=19 [1980], n=20 [1989], n=31 [1996]). Walker and Woodman (2002) concluded that the Beaver Dam Enclosure plot population had collapsed as of 2001 and that disease was likely responsible for the decline.

The Littlefield study plot was surveyed in 1993, 1998, and 2002. Observations on this PSP included 46 tortoises in 1993, 80 tortoises in 1998, and 37 tortoises in 2002. A total of 44 carcasses were collected on the Littlefield plot during the 2002 survey of which 30 individuals (68%) were juveniles (Young et al. 2002). Cause of death was determined for only 22 of the 44 carcasses, however; based on cause of death, number of carcasses from previous years on the Littlefield plot, and mortality patterns in the surrounding region, Young et al. (2002) concluded that the Littlefield plot was experiencing a die-off during 2002. LDS transects surveyed on the Littlefield plot in 2002 did not yield a large enough sample size for statistically valid estimates of density (Young et al. 2002).

Apparent declines within the PSPs in the vicinity of the Gold Butte-Pakoon Conservation Area are difficult to confirm because research methods have not been consistent among studies, or even among years within single studies. The DTRPAC conducted within-DWMA kernel analyses on data collected during 2001 (Tracy et al. 2004) (2001 was the only year with sufficient data to conduct the analyses).

Kernel analyses are commonly used in home range studies but in this case were used to smooth distributions of observed live and observed dead (carcasses) tortoises. By comparing the smoothed distributions of live and dead tortoises, those areas in which carcasses would be expected but live tortoises would not (non-overlapping areas) could be identified. These non-overlapping areas in which only dead tortoises would be expected can be inferred to be areas where there were recent die-offs or population declines (Tracy et al. 2004). Tracy et al. (2004) conducted kernel analyses on 14 DWMAs and found that many of them, including the Gold Butte-Pakoon Conservation Area, had areas of non-overlap in which only dead tortoises would be expected. Recent die-offs or population declines might be inferred for these areas, however; insufficient data across multiple survey years, inconsistency in quality and quantity of data among survey areas and among DWMAs, and a lack of supporting evidence makes inferences about population declines problematic at this time.

LDS transect surveys were conducted within the Gold Butte-Pakoon Conservation Area between 2001 and 2006. The sample sizes were too small to estimate population densities, and thus population trends could not be assessed. However, population density estimates based on LDS data from the entire Northeastern Mojave Recovery Unit indicate a decrease of 13 percent between baseline data (2001 through 2005) and 2006 data (USFWS 2008b).

Population Assessment from Field Data

Field studies conducted within the Gold Butte-Pakoon Conservation Area during the fall of 2009 included a complete count of tortoises within 17 square kilometer plots in four treatment areas among three subpopulations (Figure 6). A total of 35 live tortoises was observed on the plots. Additionally, tortoise sign was detected on most plots, and a total of 62 recent carcasses was observed (Table 3). Tortoise observations on the Virgin Slope population plots ranged from 2 to 13, with an average of 5.33 tortoises. Assuming a density of 5.33 tortoises per square kilometer, we estimate the tortoise population size on the Virgin Slope to be 1,439 (based on an area of 270 km^2 for modeled desert tortoise habitat on the Virgin Slope within the Conservation Area). Tortoise densities within the Wechech and Pakoon Basins were considerably lower. Tortoise observations on the Wechech Basin plots ranged from 0 to 2, with an average of 0.6 tortoises. Assuming a density of 0.6 tortoises per square kilometer, we estimate the tortoise population size within the Wechech Basin to be 172 (based on an area of 270 km^2 for modeled desert tortoise habitat in the Wechech Basin within the Conservation Area). No tortoises were observed within the Pakoon Basin plots. Accordingly, we estimate the population size within the Pakoon Basin (with an estimated area of 720 km^2 of modeled desert tortoise habitat within the Conservation Area) to be very low, possibly approaching extirpation.

In examining the numbers of live tortoises and recent carcasses encountered on the plots, a trend is evident (Figure 7). Plots that exhibited high numbers of recent carcasses (14 carcasses on Plot 15; 12 carcasses on Plot 16; 10 carcasses on Plot 4; 7 carcasses on Plot 6) also exhibited low numbers of live tortoises (2 live tortoises on Plot 15; 0 live tortoises on Plot 16; 0 live tortoises on Plot 4; 2 live tortoises on Plot 6), suggesting that populations in the vicinity of these plots may have experienced a recent die-off. Conversely, three plots that exhibited high numbers of live tortoises (13 live tortoises on Plot 14; 7 live tortoises on Plot 3; 6 live tortoises on Plot 1) exhibited low numbers of recent carcasses (1 carcass on Plot 14; 2 carcasses on Plot 3; 0 carcasses on Plot 1), suggesting healthy populations in the vicinity of these plots.

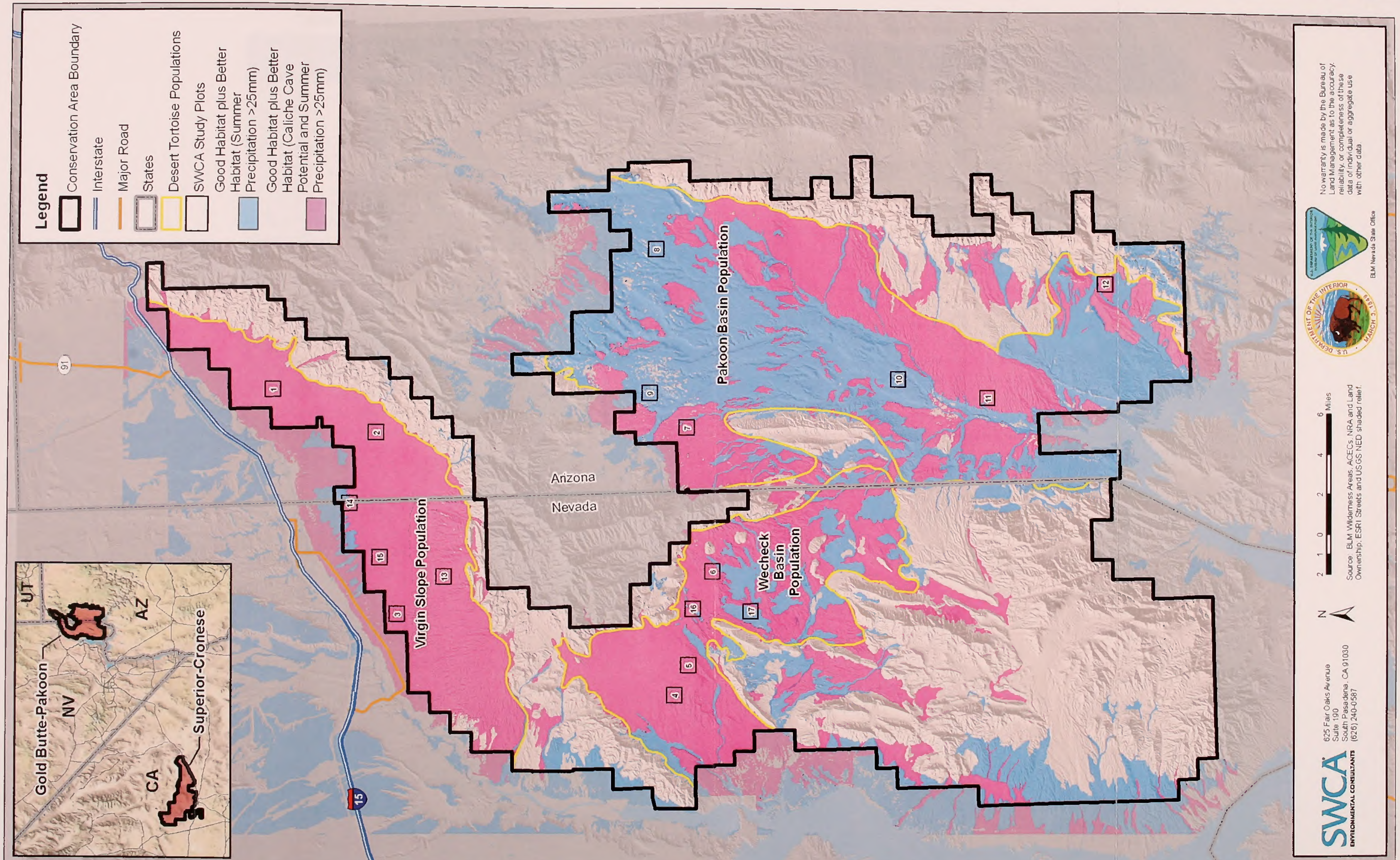

Figure 6. Desert Tortoise Subpopulations Sampled within the Gold Butte-Pakoon Conservation Area during the Fall of 2009

Table 3. Summary of desert tortoise data collected from plots within the Gold Butte-Pakoon Conservation Area during the Fall of 2009.

Subpopulation	Treatment Area	Plot Number	Adult Females	Adult Males	Adults (indeterminate sex)	Juveniles	Total Live Tortoises	Recent Carcasses (<6 years)	Tortoise Sign Observed?
Virgin Slope	Urban	3	2	2	2	1	7	2	Y
Virgin Slope	Urban	14	5	8	0	0	13	1	Y
Virgin Slope	Urban	15	0	1	0	1	2	14	Y
Virgin Slope	Control	1	1	4	0	1	6	0	Y
Virgin Slope	Control	2	0	0	0	2	2	5	Y
Virgin Slope	Control	13	0	2	0	0	2	1	Y
Wechech Basin	OHV	6	0	2	0	0	2	7	Y
Wechech Basin	OHV	16	0	0	0	0	0	12	Y
Wechech Basin	OHV	17	0	1	0	0	1	4	Y
Wechech Basin	n/a	4	0	0	0	0	0	10	Y
Wechech Basin	n/a	5	0	0	0	0	0	5	Y
Pakoon Basin	Fire	7	0	0	0	0	0	0	N
Pakoon Basin	Fire	8	0	0	0	0	0	1	Y
Pakoon Basin	Fire	9	0	0	0	0	0	0	Y
Pakoon Basin	Grazing	10	0	0	0	0	0	0	Y (old: >10 years)
Pakoon Basin	Grazing	11	0	0	0	0	0	0	Y (old: >10 years)
Pakoon Basin	Grazing	12	0	0	0	0	0	0	Y
Total			8	20	2	5	35	62	

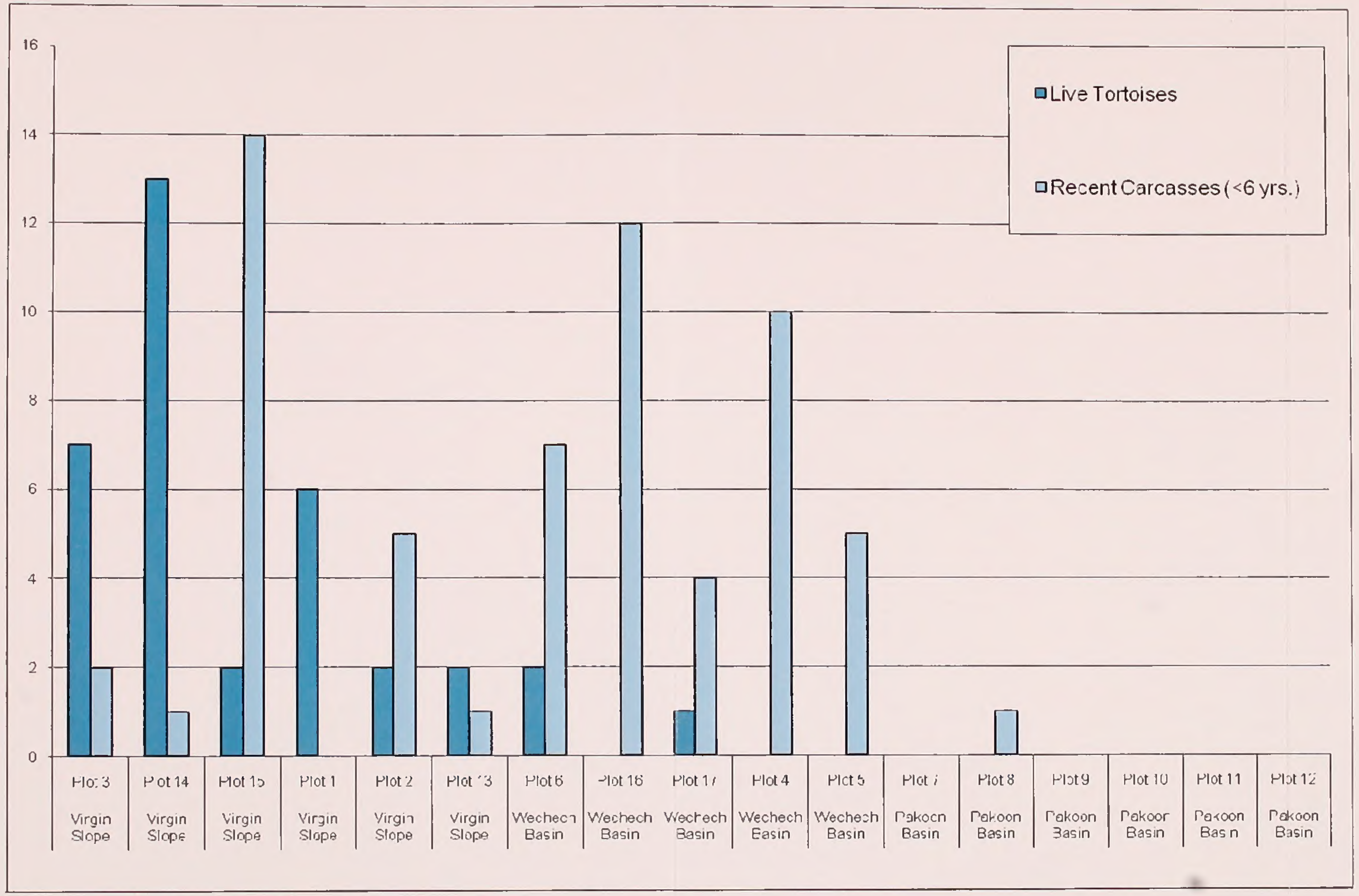

Figure 7. Distribution of live tortoises and recent carcasses observed on each plot

Superior-Cronese Conservation Area

A single PSP (the Calico PSP) occurs within the Superior-Cronese Conservation Area. This PSP was surveyed in 1978 but has not since been resurveyed; therefore, PSP data do not exist for assessing population trends within the Superior-Cronese. Data collected from PSPs in other portions of the Western Mojave Recovery Unit generally show that tortoise populations have experienced statistically significant declines throughout the region (Tracy et al. 2004). In addition, kernel analyses revealed large areas within the West Mojave where carcasses are expected but live animals are not (Tracy et al. 2004). The largest declines in densities for all size classes and for breeding females (up to 90%) occurred in the Western Mojave between the 1970s and 1990s (Berry and Medica 1995). Berry and Medica (1995) included anthropogenic causes as one of the reasons for the decline. Desert tortoise populations occurring in relatively undisturbed and remote areas with little vehicular access and low human visitation were relatively stable compared with populations in areas with high levels of disturbance, high vehicular access, and high human visitation (Berry and Medica 1995). Furthermore, approximately 14.6 percent to 28.9 percent of desert tortoises collected from Western Mojave plots in the 1970s and early 1980s showed signs of gunshots. Mortality related to vehicles was also greater in this area, where densities of dirt roads and vehicle trails are greater than other areas (Berry and Medica 1995). Other studies in this region have cited drought as a possible cause for the observed increases in mortality (Corn 1994; Karl 2002a). Demographic modeling of desert tortoise population viability in the Western Mojave based upon PSP data has suggested that populations there are at very high risk of further decline (Doak et al. 1994).

LDS transect surveys were conducted within the Superior-Cronese Conservation Area between 2001 and 2006. Sample sizes within the Superior-Cronese Conservation Area alone were often too small to estimate population densities and thus assessing population trends was not possible. However population density estimates based on LDS data from the entire Western Mojave Recovery Unit indicate a 16-percent decline in population density between baseline data (2001 through 2005) and 2006 data (USFWS 2008b).

Surveys conducted in support of military actions, in particular the Fort Irwin Land Expansion project, have provided insight into desert tortoise population trends in the Superior-Cronese Conservation Area. Various researchers were contracted by the Department of Defense to estimate the abundance of desert tortoise populations in areas bordering the southern, southwestern, and southeastern portions of Fort Irwin National Training Center (Chambers Group 1990, 1991, 1992a, 1992b, 1992c, 1993, 1994, 1996; Karl 1999, 2002a, 2002b). These surveys consisted of both plot and transect methods, and surveys were conducted in areas proposed for expansion, as well as areas south of Fort Irwin, encompassing the eastern half of the Superior-Cronese Conservation Area.

Surveys conducted to the west of Fort Irwin on the Superior Valley (70,045 acres) and Goldstone plot (1,472 acres) indicated low population densities. Desert tortoise abundance on the Superior Valley plot (66,000 acres) was estimated at 626 to 658 adult tortoises (Charis Professional Services Corporation 2003*)* and considered low to very low; however Karl (2002a) suggests that this area has probably historically supported low densities of tortoise based on habitat and elevation factors. Abundance could not be measured for the Goldstone plot due to small sample sizes, but data for both areas indicate low population densities, with nearly 50 percent of the area within the Superior Valley exhibiting estimates of three or fewer tortoises per square mile. Densities also appeared low on the Goldstone plot, where population estimates, where possible, were less than five tortoises per square mile.

Surveys conducted on the proposed expansion area to the east of Fort Irwin (the Eastgate parcel) indicated low to very low tortoise densities (Karl 2002a, 2002b). Tortoise density was estimated at 0 to 1 tortoises per square mile (depending on the terrain), with a total of 288 tortoises estimated to be on the site in 2002 (Karl 2002a, 2002b).However, the transect method used to sample this plot does not yield reliable density data, and estimates remain inconclusive.

Surveys conducted on the proposed expansion area to the south of Fort Irwin on the UTM90 parcel indicated that tortoise densities were higher than on other parcels. Tortoise abundance north of the Alvord Slope was estimated at 430 to 441. An additional 96 to 124 tortoises were estimated to occupy the eastern portion of the parcel. Densities ranged from 0 to 85.2 adult tortoises per square mile in areas supporting suitable desert tortoise habitat, whereas the mountainous areas within the parcel exhibited densities similar to those encountered on the Eastgate parcel (Karl 2002a, 2002b). Karl (2002a, 2002b) concluded that some parts of the Fort Erwin expansion area where habitat conditions were suitable for desert tortoise, and where tortoise densities were moderate in 2002, might have historically maintained higher densities. Moderate densities observed in 2002 may be the result of mortality and depressed reproduction resulting from extended drought conditions (Karl 2002a, 2002b).

Despite the fairly extensive dataset collected in support of the Fort Irwin land expansion, trends in the sampled desert tortoise populations could not be evaluated, as none of the plots or transects were sampled in consecutive years.

3.3 Threats Analysis

The following discussion reviews the various threats to desert tortoises, including human developments (urbanization, roads, railroads, utilities, landfills, and anthropogenic water sources), human activities and by-products of activities (OHV use, livestock grazing, agricultural practices, mineral extraction, military activities, litter and illegal dumping, toxin and pollutant deposition, degradation of air quality, climate change, collection/poaching of tortoises by humans, and translocation of tortoise populations), and biological and environmental threats (invasive plants, fire, disease, subsidized predators, and drought). The following discussion details how each of these threats contribute to 1) desert tortoise mortality; 2) habitat loss, fragmentation, or degradation; 3) facilitation of human access to areas supporting desert tortoise populations; 4) interactions with and cumulative effects with additional threats; 5) their occurrence or potential for occurrence on private, state, or federal land in-holdings; and 6) their distribution or occurrence within each of the Conservation Areas. Following the review of each threat, we provide scores and a ranking of the importance of the threats within each Conservation Area based upon these six factors.

3.3.1 Human Developments

Urbanization

Ultimately, the conversion of undeveloped lands to urbanized development results in transitions to the soil, vegetation, and wildlife communities that are more typically associated with developed landscapes. However, the presence of urbanized areas within or adjacent to desert tortoise habitat may also present significant edge effects by facilitating human access and use to adjacent desert areas. These effects that result from the encroachment of human development into desert tortoise habitat make tortoise populations vulnerable to poaching, release of captive tortoises, deposition of garbage and litter, increased recreational activities, increased predation by subsidized species or species typically associated with urbanized areas, and increased risk to disease (Berry and Nicholson 1984; Arizona Interagency Desert Tortoise Team [AIDTT] 2000; Boarman 2002a).

<u>Impacts</u>

The conversion of desert habitats to various levels of residential, commercial, and industrial development provides both direct and indirect pressures to desert tortoises and desert tortoise habitat. Urbanization results in the permanent loss of desert tortoise habitat, resulting in a network of roads, utility corridors,

residential dwellings/commercial structures and associated activities, and undeveloped areas containing nonnative vegetation (e.g. parks, landscaped areas). Other impacts include degradation of habitat from dumping of trash and litter, increased predation rates from subsidized predators, and possibly increased incidence of disease in tortoise populations in the vicinity of human developments.

Previous researchers have documented that desert tortoise populations in the vicinity of urbanized areas are particularly depauperate. In one extensive study across 90 square miles of undeveloped, non-agricultural habitat surrounding the city of Lancaster, Tierra Madre Consultants (1991) located only one live desert tortoise, and attributed that paucity of tortoise sign to indicators of human presence across the study area, including domestic dogs, trash/litter, shotgun shells/rifle cartridges, OHV tracks, ravens, and evidence of sheep grazing. Edwards et al. (2004) list factors associated with urbanization, including domestic/feral dog attacks, vulnerability to disease transmission from escaped/released captive tortoises, and lack of immigration by other tortoises due to barrier effect by roads and other development as rationale for their suggestion that a tortoise population of less than 30 individuals surrounded by urbanized areas of Tucson will likely experience a population decline and possibly localized extirpation.

Facilitation of Human Access to Desert Environments

Urbanized localities also serve as staging areas—either for local recreationists or recreational users who originate from urban centers on a region-wide scale—that provide increased human access to desert areas. Most significant of the recreational uses of desert natural areas is OHV use, which can kill tortoises or destroy or degrade habitat, is common adjacent to urban areas (see OHV section for detailed information on impacts). Other recreational activities, including target shooting, camping, picnicking, sightseeing, hiking, bird watching, horse riding, and rock and other mineral collecting that are common in areas adjacent to urban centers can result in desert tortoise habitat destruction. The increased recreational use of desert environments in the vicinity of urbanized areas likely results in the collection and killing of tortoises (see Collection and Poaching by Humans section for a full account). Other human impacts associated with recreational use of desert environments in the vicinity of urbanized areas include the increased risk of anthropogenic fires.

<u>Cumulative and Interactive Effects with Other Threats</u>

Disease

Humans are collectors of tortoises, and the release of captive (pet) tortoises into areas supporting wild populations may increase the risk of disease transmission from released tortoises to native tortoises. URTD has been identified in captive tortoises, and the release of these tortoises into the wild may aid in spreading the disease across desert tortoise habitat and to native tortoises (Jacobson 1993). The interface between developed areas and desert tortoise habitat creates a unique situation for captive tortoises to be released. Berry et al. (2006) reported that URTD was more common in captive tortoises that were living in urbanized locales and near the interface of development and desert habitats than in those living in remote areas (see Disease section for a full account of this threat).

Litter and Illegal Dumping

Garbage and litter also have negative impacts on desert tortoises, and this threat is common within and adjacent to urbanized areas (discussed in more detail in the Litter and Illegal Dumping section). Boarman (2003) identified the indirect effects of trash attracting and supporting predators such as common ravens, coyotes, or feral dogs, which can harass or kill desert tortoises (see review in Subsidized Predators section). In addition, illegal dumping of trash is likely more common in the vicinity of urbanized areas.

Subsidized Predators

Urbanized areas are major sources of food and water for subsidized predators, and likely contribute substantially to the growth and spread of common raven and coyote populations. These predators are not subsidized only by garbage and litter that scatters from urbanized areas but also by point sources within urban areas, such as dumpsters, trash cans, and irrigation. Kristan and Boarman (2003) observed greater numbers of ravens near human developments; numbers were highest near a housing area and landfill. In addition to the effects of subsidized predators, the juxtaposition of residential development and desert tortoise habitat creates situations in which desert tortoises occupying habitats adjacent to urbanized areas have a higher likelihood of coming into contact with domestic pets. Both domestic and feral dogs have been identified attempting to predate on desert tortoises (Bjurlin and Bissonette 2001; Berry et al. 2006). These attacks have been correlated with proximity to urban development; Berry et al. (2006) indicated that preliminary studies demonstrated a more common occurrence of dog attacks on desert tortoises near urban development (within 3 km) (Demmon and Berry 2005) than in more remote portions of the desert. The Desert Tortoise Recovery Plan (USFWS 1994a) cites several examples, through personal communication with desert tortoise researchers and agency staff, of dogs (either singly or in packs) attacking desert tortoises, including digging up tortoise burrows, harassing tortoise individuals, and gnawing on tortoise scutes and bones. A full account of the effects of subsidized predators to desert tortoise populations is provided in the Subsidized Predators section.

Other Cumulative and Interactive Threats

A variety of other cumulative and interactive threats are associated with urbanized areas. Roads and utility corridors originate from urbanized areas and enter adjacent desert areas. The roads provide entry into desert habitats occupied by desert tortoises by OHV users and other humans seeking recreational opportunities. Desert tortoise populations occupying habitats adjacent to urbanized areas are likely affected by collecting and poaching by humans to a greater degree than those occupying more remote locations. Disturbances associated with development of urbanized areas likely contribute to the spread of invasive plants into adjacent desert environments. Toxins, pollutants, and poor air quality originate from urbanized areas. Desert habitats adjacent to urbanized areas are more susceptible to the threat of wildfire. Anthropogenic water sources are more abundant within and adjacent to urbanized areas, and landfills are often located a short distance away from urban areas. Finally, homes and motorized vehicles within urbanized areas are the primary sources of pollutants and gases that contribute to climate change.

Distribution within Conservation Areas

Although urbanization is not likely a significant threat to the direct conversion or elimination of habitat within each of the Conservation Areas, adjacency issues posed by varying degrees of development likely negatively affect tortoise populations and their habitats within desert natural areas. Following is a discussion of the site-specific manners in which urbanized environments affect each of the Conservation Areas.

Gold Butte-Pakoon

The cities of Mesquite, Nevada and Littlefield, Arizona are situated on the north side of the Virgin River along the northern border of the Gold Butte-Pakoon Conservation Area and represent the most concentrated area of development adjacent to this Conservation Area. Additional smaller urbanized areas exist along the Nevada Highway 170 corridor directly adjacent to the Conservation Area, and include the towns of Riverside and Bunkerville. Additional low-density developments are located southeast of Mesquite in Mohave County, Arizona, and the areas surrounding Littlefield, Arizona. The locations of urbanized areas adjacent to the Conservation Area are presented in Figure D-1 in Appendix D.

Human populations in the vicinity of the Gold Butte-Pakoon Conservation Area have increased substantially between 1990 and 2008 (Table 4). Additionally, using remote sensing techniques we detected a considerable amount of change due to urbanization outside of the Conservation Area in the Mesquite vicinity, comprising 3,006 acres during the period between 1990 and 2001, and 2,271 acres during the period between 2001 and 2008. Urbanization and population growth in the vicinity of the Gold Butte-Pakoon Conservation Area will likely be facilitated in the future because of recent and planned disposals of BLM lands. The Lincoln County Land Act (2000) will allow for the disposal of approximately 13,500-acres in southeastern Lincoln County, directly adjacent to Mesquite. Disposal of these lands will likely facilitate the expansion of Mesquite development to the north, effectively doubling the area of developed lands adjacent to the Gold Butte-Pakoon Conservation Area. Additional land disposals, such as the Arvada land sale, are planned for BLM land in-holdings located along the lower Virgin Slope outside of Mesquite and Littlefield, which will contribute further to development and urbanization of the area.

Table 4. Human population growth in the vicinity of Mesquite, Nevada and Littlefield, Arizona during the period of study (1990-2008)

City/Town	1990 Population	2000 Population	2008 Population
Zip code 86432 (includes Beaver Dam and Littlefield) †		1,053	
Bunkerville*	456		1,171
Mesquite†	1,871	9,389	16,444
Moapa Valley*	4,051		7,200

*Source: Clark County demographics (http://www.accessclarkcounty.com/depts/comprehensive_planning/demographics/Documents/CCHistoricalPopSummaryWorksheet1990toPresent.pdf)

† Source: U.S. Census data (factfinder.census.gov)

We detected several areas that experienced a loss of vegetative cover or soil disturbance from urbanization in the Conservation Area vicinity (Figure 8; Figure E-1 in Appendix E). During the period under investigation (1990-2008), there was a consistent pattern of development to the south of Mesquite, reducing the distance between the urbanized locales in the Mesquite vicinity and the Gold Butte-Pakoon Conservation Area. Between 1990 and 2001, we detected 3,006 acres of change that were attributed to new urbanization in the greater Mesquite-Bunkerville-Littlefield area adjacent to and outside of the Conservation Area. Between 2001 and 2008, we detected an additional 2,271 acres of change there. A portion of the new urbanized areas occurred in the vicinity of Scenic, Arizona, a community located directly adjacent to the Conservation Area.

During field work within the Gold Butte-Pakoon Conservation Area, we detected several patterns of interactive threats near urbanized areas. The Urban Treatment Area generally exhibited greater incidences of OHV trails and trash dumps, as well as evidence of greater numbers of subsidized predators and human occurrences when compared to other treatment areas (Table 5). The plots in the Urban Treatment Area were also characterized by evidence of grazing and invasive plants (Table 6).

Superior-Cronese

The Redlands Institute projected urban growth within the Superior-Cronese Conservation Area to be low or negligible over the next 50 years (Redlands Institute 2004). However, urbanization directly adjacent to or within in-holdings inside this Conservation Area may result in increased human activity and spill-over

of indirect effects associated with urbanization. The city of Barstow, California, situated immediately south of the Superior-Cronese Conservation Area, represents the most concentrated area of urbanized development. Other urbanized areas adjacent to or within the Conservation Area include those associated with the Interstate 15 corridor to the north and east of Barstow (including the communities of Yermo, Toomey, Harvard, Afton, and Cronese Valley), and the western limits of Barstow and the community of Lenwood along California Highway 58. There are three areas within the Conservation Area boundaries that support human developments, including low-density ranch communities in the vicinity of Harvard and Hinkley, as well as a number of ranches in the vicinity of Coyote Lake (Figure D-2 in Appendix D).

The population of the city of Barstow has grown little during the period between 1990 and 2008 (Table 7). Despite this, some effects of urbanization, primarily through development, were observed. Disturbances detected by remote sensing that was associated with development outside of the Conservation Area in the vicinity of Barstow accounted for approximately 637 acres (Figure E-22 in Appendix E).

Table 5. Human population growth in Barstow, California during the period of study (1990-2008)

City/Town	1990 Population	2000 Population	2008 Population
Barstow[†]	21,472	21,119	24,596

[†] Source: U.S. Census data (factfinder.census.gov)

The effects of urbanization in the vicinity of the Superior-Cronese Conservation Area have not been studied and are not completely understood, though studies from other portions of the West Mojave vicinity provide clues about their potential effects. Ongoing data collection at the Daggett Study Site indicates that disease incidence (including URTD) in tortoises is higher for populations that reside within a 'core' area located near a low density human development (Mack and Berry 2009). Information from the Fort Irwin vicinity indicates that disease incidence in tortoises was higher in areas closer to base offices, the Ft. Irwin cantonment, and paved roads (Berry et al. 2006). Additionally, tortoise densities were lower and trash deposits higher in areas of increased surface disturbance (Berry et al. 2006).

Table 6. Relative density and counts of threat occurrences within plots on the treatment areas within the Gold Butte-Pakoon Conservation Area.

	Single Track/Single Pass	Single Track/Multiple Pass	Double Track/Single Pass	Double Track/Multiple Pass	Paved Road	Graded Dirt Road	Ungraded Dirt Road	Trash (Dump)	Trash (Isolate)	Trash (Windblown)	Trash (Other)	Predators (Feral Dogs)	Predators (Coyote)	Predators (Raven)	Predators (Other)	Human (Campsites)	Human (People)	Human (Other)
	Relative Density of OHV Trails*				Relative Density of Roads*			Number of Trash Deposit Observations				Number of Predator Observations				Number of Human Occurrence Observations		
Control Treatment Area																		
Plot 1	8	0	2	3	0	0	69	1	68	16	2	0	83	2	0	0	0	3
Plot 2	6	1	14	0	0	0	35	0	117	36	0	0	116	0	0	0	2	1
Plot 13	2	0	0	0	0	0	0	0	41	16	0	0	39	2	0	0	0	0
Total	16	1	16	3	0	0	104	1	226	68	2	0	238	4	0	0	2	4
Mean	5.33	0.33	5.33	1	0	0	34.67	0.33	75.33	22.67	0.67	0	79.33	1.33	0	0	0.67	1.33
Urban Treatment Area																		
Plot 3	14	5	19	62	0	0	30	1	30	18	0	0	168	3	0	0	1	1
Plot 14	46	28	191	34	0	13	0	16	1008	76	22	8	12	1	1	0	0	9
Plot 15	7	0	56	7	0	20	2	0	30	19	8	0	224	0	0	0	0	96
Total	67	33	266	103	0	33	32	17	1068	113	30	8	404	4	1	0	1	106
Mean	22.33	11	88.67	34.33	0	11	10.67	5.67	356	37.67	10	2.67	134.67	1.33	0.33	0	0.33	35.33
OHV Treatment Area																		
Plot 6	5	0	3	0	0	0	0	0	2	20	0	0	50	1	1	0	0	1
Plot 16	33	1	35	111	0	2	100	3	50	11	0	0	46	0	0	0	0	3
Plot 17	102	43	53	121	0	0	0	0	18	13	0	0	42	1	1	0	4	68
Total	140	44	91	232	0	2	100	3	70	44	0	0	138	2	2	0	4	72
Mean	46.67	14.67	30.33	77.33	0	0.67	33.33	1	23.33	14.67	0	0	46	0.67	0.67	0	1.33	24
Fire Treatment Area																		
Plot 7	9	0	[illegible]	0	0	0	0	0	13	[illegible]	0	0	15	2	1	[illegible]	0	24
Plot 8	0	0	0	0	0	0	0	0	28	8	0	0	21	[illegible]	3	0	0	11
Plot 9	0	0	1	0	0	0	1	0	6	8	0	0	14	0	1	1	0	27
Total	9	0	3	0	0	0	1	0	47	25	0	0	50	3	5	2	0	61
Mean	3	0	1	0	0	0	0.33	0	15.67	8.33	0	0	16.67	1	1.67	0.67	0	20.33
Grazing Treatment Area																		
Plot 10	0	0	29	0	0	0	0	0	2	0	0	0	3	0	0	0	0	6
Plot 11	0	0	4	0	0	0	0	0	8	9	0	0	31	3	0	0	0	0
Plot 12	30	0	20	0	0	0	6	0	16	8	0	0	16	2	2	0	0	0
Total	30	0	53	0	0	0	6	0	26	17	0	0	50	5	2	0	0	6
Mean	10	0	17.67	0	0	0	2	0	8.67	5.66	0	0	16.67	1.67	0.67	0	0	2

*Probability of encountering a trail or road over 1,000 linear km per km^2.

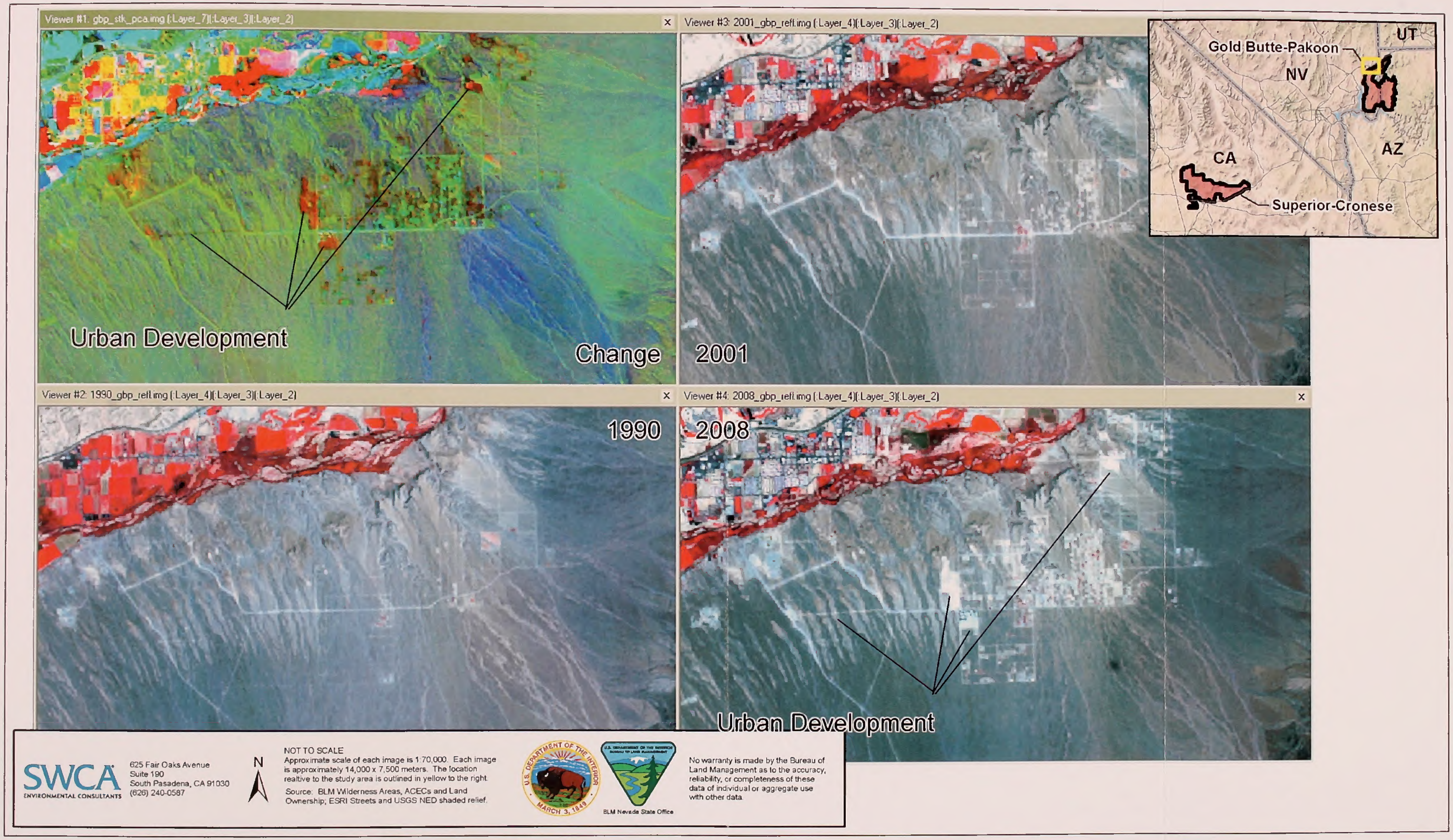

Figure 8. Remotely Sensed Urbanization near the Gold Butte-Pakoon Conservation Area

The remotely sensed change image (upper left) shows several light green and dark red features representing vegetation removal from 1990 (lower left), through 2001 (upper right), and 2008 (lower right). This area south of Mesquite, Nevada, is immediately north of the Gold Butte-Pakoon Conservation Area and shows consistent growth and development, which threatens desert tortoise habitat within the Conservation Area.

Table 7. Qualitative descriptions of grazing, invasive plants, and wildlife evidence observed on plots within the treatment areas

Plot	Grazing Evidence	Red Brome	Mediterranean Grass	Mustard	Other Invasive Plants	Fire Evidence
Control Treatment Area						
1	Cow dung and tracks observed	Common	Ubiquitous	Not Present	Not Present	Not observed
2	Cow dung and tracks observed	Common	Common	Not Present	*Erodium* (Ubiquitous)	Not observed
13	Cow dung observed	Ubiquitous	Common	Not Present	*Erodium* (Ubiquitous)	Not observed
Urban Treatment Area						
3	Fresh cow dung, tracks, and trails observed	Ubiquitous	Common	Not Present	Not Present	Not observed
14	Cow dung and one carcass observed	Common	Common	Not Present	*Erodium* (Common)	Not observed
15	Cow dung observed (primarily along northern edge of plot)	Ubiquitous	Common	Not Present	*Erodium* (Common)	Not observed
OHV Treatment Area						
6	Cow dung, tracks, trails, and live cattle present. Watering trough observed.	Common	Common	Not Present	Not Present	Not observed
16	Cow dung, tracks, trails, terracettes, and bones; burro tracks observed	Ubiquitous	Common	Not Present	Not Present	Not observed
17	Cow dung, tracks, and trails observed	Common	Common	Not Present	Not Present	Not observed
Fire Treatment Area						
7	Cow dung, trails, and tracks; sheep dung observed	Ubiquitous	Ubiquitous	Not Present	*Erodium* (Ubiquitous)	Extensive evidence of fire on entire plot
8	Cow dung observed	Ubiquitous	Not present	Not Present	*Erodium* (Ubiquitous)	Extensive evidence of fire on entire plot
9	Cow dung, trails, and terracettes; burro dung observed	Ubiquitous	Ubiquitous	Not Present	*Erodium* (Ubiquitous); thistle (*Cirsium* sp.) (Common)	Extensive evidence of fire on entire plot
Grazing Treatment Area						
10	Burro dung and trails observed	Sparse	Sparse	Not Present	*Plantago* (Uncommon)	Not observed
11	Cow and burro dung, tracks, trails, and wallows observed	Common	Common	Sparse	Not Present	Not observed
12	Cow and burro dung, tracks, and trails observed	Ubiquitous	Sparse	Not Present	Thistle (Sparse)	Old wildfire evidence observed on a small portion of the plot

Roads

One of the most important and best understood factors contributing to the degradation of the desert ecosystem is the proliferation of roads across the landscape. The effects of roads on both the physical and biological environment are numerous and well documented. Physical impacts include soil compaction, increased soil erosion, pollutant deposition, and increased noise pollution. Biological impacts include mortality of desert tortoises from vehicle strikes, changes to adjacent vegetation, spread of invasive plants, attraction of vertebrate predators, and barriers to dispersal. In addition, roads facilitate human access into areas supporting desert tortoise.

The BLM (2006) defines the following categories of roads and trails:

- Road: a linear route (paved or unpaved) declared a road by the owner, managed for use by low-clearance vehicles having four or more wheels, and maintained for regular and continuous use.
- Primitive road: a linear route managed for use by four-wheel drive or high-clearance vehicles.
- Trail: a linear route managed for human-powered, stock, or off-highway vehicle forms of transportation (including motorcycles) or for historical or heritage values.

Based upon these classifications, the following discussion focuses on the effects of roads (paved and unpaved but graded or maintained in a manner that allows for passage by low-clearance vehicles at relatively high speeds) to desert tortoises and their habitat. The impacts of OHV use along trails, primitive roads, and across desert natural areas are discussed in the OHV section.

Impacts

Mortality

When wildlife attempt to cross roads during daily or seasonal movements, they are at risk of being struck by vehicles traveling along the road. The role of animal-vehicle collisions on population dynamics, species behavior, and habitat permeability has received increasing attention recently. Studies have shown that mortality rates vary widely according to the type of habitat adjacent to the road, the surrounding topography, and the road or route characteristics (e.g., road width, traffic density and speed, type of pavement, presence of median barriers) (Ward 1982; Bashore et al. 1985; Foster and Humphrey 1995; Evink et al. 1996; Evink et al. 1998).

Road kill mortality may lead to significant local declines in populations over time, either from the outright loss of individuals in a population or from unfavorable changes to the demographic composition of a population, even if minimum-area requirements for habitat are maintained. As such, habitats bisected by roads may represent population sinks for any species that, as part of its daily or seasonal movement, may be subjected to crossing a road as it moves from one habitat fragment to another (Kline and Swann 1998). A decline in wildlife populations would therefore occur if the animal-vehicle collision mortality rate exceeds the rate of reproduction and immigration, (Beier 1993; Bruinderink and Hazebrook 1996; Moore and Mangel 1996; Forman and Alexander 1998). Even in situations where the frequency of animal-vehicle collision mortality is relatively low throughout the majority of the year, seasonal increases in animal road-crossing activity (Feldhammer et al. 1986; Bruinderink and Hazebroek 1996) or increased periods of traffic (McCaffery 1973) may affect certain wildlife populations.

The impact of vehicular traffic along roads on desert tortoise–vehicle collisions has been studied throughout various portions of the Mojave Desert, with most studies indicating that vehicles are a major contributor to desert tortoise mortality. During three surveys conducted along California Highway 58 over a 2.5-year period, the remains of 39 dead tortoises were observed (Boarman et al. 1993; Boarman 1994).

Boarman et al. (1993) reported finding the remains of 61 tortoises along 66 miles of highway edge along California Highway 58. Several studies have identified a 'mortality sink' or depression in desert tortoise population densities near roads. The area of influence that roadways have on desert tortoises varies greatly, and may depend on a variety of factors, including topography, vegetation characteristics, traffic volume, traffic speed, and tortoise densities (Boarman and Sazaki 2006). Nicholson (1978) reported a significant decrease in tortoise sign up to a distance of 1.6 km from a road, and determined that the road effect was magnified along roads that were constructed earlier (i.e. older roads) and had greater traffic volumes. Karl (1989) and von Seckendorf and Marlow (1997; 2002) report even greater zones of influence, identifying distances of up to 4.6 km and 3.2 km, respectively, from highways where tortoise populations were depressed. Additional studies have found less extensive zones of influence, including LaRue (1993), who observed a significant linear increase in tortoise sign as distance from the roadway increased up to a distance of 305 meters, and Boarman and Sazaki (2006), who determined that tortoise populations were depressed within a zone extending up to between 400 and 800 meters from California Highway 58. Von Seckendorff Hoff and Marlow (2002) suggest that, given the potential zones of influence beyond the actual road footprint that may negatively affect tortoise distribution, the cumulative impact of a road network may reduce the effective area of any conserved habitat.

Habitat Fragmentation

Habitat fragmentation occurs when areas of suitable habitat are separated from each other by development, primarily linear developments such as roads, railroads, utility corridors, and fencing, but also from point location developments such as mines, landfills, or other urban structures. While fragmentation may not always result in direct mortality, it can greatly inhibit the dispersal of desert tortoises and is the cause of approximately 1.7% of overall desert tortoise mortality (USFWS 2008a). Desert tortoises attempting to cross barriers between suitable habitat areas may become the victims of road kill or injury from vehicles, or may be predated upon by ravens utilizing transmission towers or other utility structures as perches. Barriers to movement and population connectivity also have implications to exchange of genetic material, which can lead to inbreeding, and may result in eventual mortality of individuals (Boarman and Sazaki 1996).

The presence of roadways is one of the principal factors contributing to habitat fragmentation (Meffe and Carroll 1997). Roads separate once continuous habitat and may pose as substantial barriers to the movement of species (Forman and Alexander 1998). Roadways have been identified as threats to the long-term persistence of rare and threatened species, including desert tortoises (Boarman and Sazaki 1996) and the effects of the road may extend well beyond the actual road footprint. Even ongoing road maintenance along unpaved roads can lower the roadbed and effectively raise the roadside berms to such a degree that desert tortoises entering the roadway cannot exit due to the berm height. The inability of individuals to cross roads may eventually lead to the isolation of subpopulations, which in turn can promote increased inbreeding and a lack of genetic exchange with other subpopulations (Dobson et al. 1999) or the reduced potential for recolonization when extirpations occur as a result of localized population fluctuations and catastrophic events (Yanes et al. 1995). Ultimately, isolation of population may lead to declines in the genetic diversity of a population, which is required for adaptation to variable conditions and possible founder effects (Hanski and Simberloff 1997; Hanski 1999).

Habitat Degradation

Many of the physical impacts created by vehicular travel across the desert soils have direct and indirect effects on vegetation. Direct impacts include an increase in soil strength, particularly soil compaction, which can decrease the amount of vegetative cover along many unpaved roads. However, improved conditions occur along many paved roads, where elevated soil moisture levels can support greater densities of vegetation. The impacts of soil compaction are discussed in the OHV section; here, we

discuss the effect of impervious road surfaces (e.g. pavement, graded improved roads, gravel roads) on vegetation communities.

The impermeable surfaces of roads create a situation in which precipitation does not infiltrate into the ground; rather, it flows to areas adjacent to the roadbed, thus increasing the overall moisture availability in the immediate vicinity of the road. Many coarse-textured soils, which are typically found in association with paved roads (roadbed materials laid down prior to paving), permit good water infiltration along road edges (Hillel and Tadmor 1962), and improved gravel roads may experience similar conditions. This increase in moisture availability may promote greater plant vigor along roadsides compared with that of the surrounding areas (Johnson et al. 1975), sometimes as far as 200 meters from the road edge (Angold 1997). There have been numerous studies documenting greater vegetation cover along roadsides and rights-of-way than in adjacent areas (Johnson et al. 1975; Vasek et al. 1975a, 1975b; Holzapfel and Schmidt 1990; Lightfoot and Whitford 1991); standing crop, which is a measure of primary productivity, was 17 times greater along paved roads than it was in nearby undisturbed areas (Johnson et al. 1975).

This increase in vegetative cover along roadsides may attract desert tortoises. Boarman et al. (1997) report that several plant species that are favored by desert tortoises exist along roadsides throughout the Mojave Desert (see Jennings 1992). This attraction may result in an increased risk of being struck by vehicles. Alternatively, due to the increased potential for invasive, non-native annuals and other early successional plants to establish rapidly along roads, compared with native perennials, which may require at least five years to become established (Adams et al. 1982a; Prose et al. 1987; Lovich and Bainbridge 1999), road edges may harbor plant species that are less palatable and have lower nutritional value for tortoises than native forage (Jennings 1993; Avery 1997).

Facilitation of Human Access to Desert Environments

The use of roads by the traveling public provides additional opportunities for anthropogenic threats. The numerous paved and unpaved roads that proliferate in the desert provide numerous access opportunities for tortoise collectors. Berry et al. (1996) determined that the collecting or poaching of desert tortoises tended to occur near roads, including those roads that were lightly maintained. In the study, 7.7% of detected tortoise burrows demonstrated some type of evidence that humans had excavated the burrows, and that human-excavated burrows were observed closer to dirt roads. Grandmaison et al. (2009) reported that 8% of motorists attempted to illegally collect tortoises positioned on roads in a study at 38 sites involving 474 human-tortoise interactions, and concluded that a "biologically significant" number of tortoises are collected by motorists. For a more detailed discussion of these anthropogenic threats, see the Collection and Poaching by Humans section.

<u>Cumulative and Interactive Effects with other Threats</u>

Litter and Illegal Dumping

Humans traveling along roadways deposit considerable amounts of litter and trash (see Litter and Illegal Dumping section for a full account of the impacts of litter to tortoises). Accumulation of trash adjacent to roadways likely provides an attractant to subsidized predators, including ravens and coyotes (see Subsidized Predators section for an account of the effects). Humans may also use roads, particularly those that access more remote portions of the desert, to dispose of hazardous or toxic waste (discussed in the Toxin and Pollutant Deposition section), which may potentially have localized impacts on desert tortoise populations (see review in Boarman 2002a).

Air Quality, Toxins, and Pollutants

Paved roads can also impact the physical environment through the deposition of heavy metals and particulates. Vehicles emit a variety of heavy metal pollutants, including lead, zinc, copper, nickel, and chromium; the role of ozone, sulfate, and nitrate emissions on desert tortoises are discussed in the Air Quality section. One of the most significant heavy metal pollutants is lead. Lead particulates are typically highest in portions of the desert adjacent to major highways (Quarles et al. 1974) and tend to increase with traffic volume (Motto et al. 1970; Wheeler and Rolfe 1979). Lead concentrations are highest along the side of the road; however, gradients of increased lead concentrations existed for about 80 meters on either side of a highway, and then declined at a slower rate away from the road (Daines et al. 1970; Quarles et al. 1974). Quarles et al. (1974) found lead concentrations in the soil along two transects dropping from 543 parts per million (ppm) and 190 ppm at the road edge to 47 ppm and 5 ppm 10 meters from the road edge.

Both plants and animals are susceptible to lead uptake. While most of the lead intake by plants is due to surface deposition (Motto et al. 1970; Smith 1976), plants may also obtain lead through both the leaves and roots (Motto et al. 1970). Lead concentrations in plants dropped from 158 ppm and 84 ppm at two transects near the road edge to 78 ppm and 30 ppm at two transects 30 meters from the edge (Quarles et al. 1974). Chaffee and Berry (2006) collected soil, stream sediment, and plant samples from a desert tortoise study area bisected by a paved road and found that lead levels were elevated, albeit weakly, at a distance of 22 meters from the pavement edge, a factor likely attributed to vehicle exhaust. Many pollutants have a potential biological significance if the plants in which they concentrate in form a large proportion of the diet of the fauna (small mammals: Quarles et al. 1974; birds: Udevitz et al. 1980; Grue et al. 1984), or if the fauna living there breathe airborne pollutants (Andrews 1990). Additional effects of the threat of pollutants to desert tortoises are discussed in the Toxin and Pollutant Deposition and Degradation of Air Quality sections.

Invasive Plants

Roads create soil disturbances conducive to the establishment of invasive plant species while concurrently removing native species (Boarman 2002a; Brooks and Pyke 2002; Brooks and Berry 2006; Jennings 1997b). In addition, because roads are linear features, they provide a vector for the spread of invasive species along their lengths, potentially into new areas where they formerly did not occur. The threat of the spread of invasive plants is discussed further in the Invasive Plants section.

Subsidized Predators

Roads likely attract subsidized predators and provide conduits for their dispersal. Trash deposited along roads and road-killed wildlife attract ravens and coyotes. The impact of raven predation on desert tortoises has been widely documented (see Subsidized Predators section), a relationship largely attributed to the presence of utility infrastructures (e.g., utility poles), which often parallel highway and road corridors (see Utilities section).

Disease

Berry et al. (2006) conducted studies on Fort Irwin and found that the presence of infectious disease in tortoises was positively correlated with proximity to paved roads. Berry et al. (2008) reported similar increases in infection rates near paved roads and freeways in the vicinity of Fort Irwin and the Superior-Cronese Conservation Area.

Other Cumulative and Interactive Threats

Roads originate from urbanized areas, and are often associated with other linear features, including utility corridors and railroads. Cumulatively, linear corridors that contain several features (e.g., roads, utility corridors, railroads, etc.) can act to fragment desert habitats more dramatically by creating more effective barriers to tortoise dispersal. Roads are also constructed to access other human developments located in desert habitats, including utility facilities, landfills and mines. Where military activities are present, roads within desert areas are used by travel vehicles and convoys. Roads within desert areas are used by OHV traffic, and roads are the location where collecting and poaching of desert tortoises often occurs. Small wildfires of anthropogenic origin are frequently associated with roads (Brooks and Esque 2002). Finally, vehicles traveling along roads contribute substantially to climate change.

Distribution within Conservation Areas

Non-paved roads constitute the majority of roadways in the Mojave Desert. Heaton (2007) describes the spatial distribution of various types of roads within multiple desert tortoise study areas, including the Superior-Cronese and Gold Butte-Pakoon Conservation Areas. This (Heaton 2007) analysis determined that the areas with the highest road counts (as measured by vehicle tracks per km) were concentrated in the Western Mojave Recovery Unit. Track types included graded roads, ungraded roads, and single-track and double-track routes. Throughout the Western Mojave Recovery Unit, the highest road counts occurred within the Fremont-Kramer, Superior-Cronese, and Ord-Rodman critical habitat units. Graded roads, as defined by a road with a berm along the outer edge, were most often found adjacent to populated areas and within the Superior-Crones Conservation Area, particularly in the vicinity north of Barstow; the Gold Butte-Pakoon Conservation Area had a lower density of graded roads. Ungraded roads, defined as a road without a berm, showed moderate densities in the central Superior-Cronese Conservation Area; the Gold Butte-Pakoon Conservation Area had a lower density of ungraded roads. When combining graded and ungraded road distribution data, the south-central portion of the Superior-Cronese Conservation Unit showed the highest concentration of road (10–20 roads/km). Spatial distributions of single- and double-track routes are described in the OHV section.

Within or directly adjacent to the Gold Butte-Pakoon Conservation Area, roads include Interstate 15, Nevada State Route 170, Grand Gulch Road/Grand Wash Road/Mohave County Road 113, Mohave County Road 111, Pakoon Springs Road, Nays Ranch Road, Gold Butte Road, Whiterock Road, Mohave County Road 101, Mohave County Road 5, Mohave County Road 103, and numerous BLM and National Park Service (Lake Mead National Recreation Area) roads (Figure D-3 in Appendix D).

Several paved and major unpaved roads either bisect or border the Superior-Cronese Conservation Area, including Interstate 15, California Highway 58, Fort Irwin Road, Ghost Town Road, Calico Road, Alvord Mountain Road, Field Road, Powerline Road, Hinkley Road, Irwin Road, Helendale Road, Harper Lake Road, Phoenix Road, Lockhart Road, Hoffman Road, Black Canyon Road, Mule Canyon Road, and numerous BLM roads (Figure D-4 in Appendix D). Using remote sensing techniques, we detected the widening and oiling of the Manix Trail and the widening of Fort Irwin Road within the Superior-Cronese Conservation Area between 2001 and 2008 (Figure 9; Figure E-14 in Appendix E).

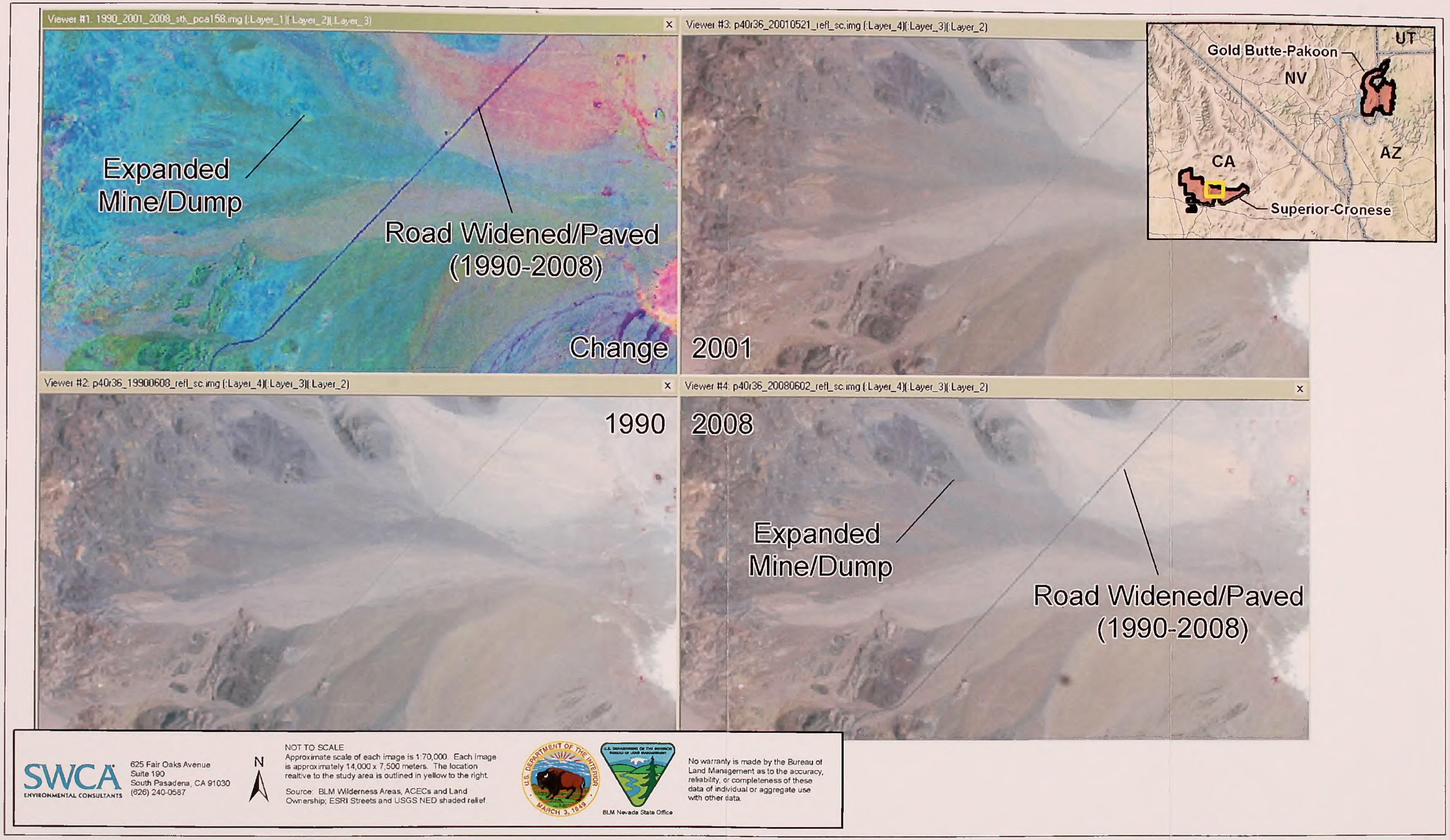

Figure 9. Remotely Sensed Changes to Fort Irwin Road

The remotely sensed change image (upper left) shows a purple linear feature that represents widening and paving of Fort Irwin Road between 2001 (upper right) and 2008. This change is not apparent in the false color images (red-near infrared band, green-red band, and blue-green band), but become apparent when looking at the shortwave infrared (band 5). Also detected within this portion of the Conservation Area is a light green area representing vegetation removal and excavation at the Black Marble Quarry mine sometime between 1990 (lower left) and 2008 (lower right).

Von Seckendorff Hoff and Marlow (2002) provide perhaps the most comprehensive examination of the effects of different roads on tortoise mortality, with an examination of tortoise sign in the vicinity of graded roads, two-lane highways, and 4-lane highways. We used this study as a basis for assigning tortoise mortality sinks to roads within and adjacent to the Conservation Areas in order to assess road effects on tortoise populations there (Table 8; Figures E-2, E-12, and E-13 in Appendix E).

Table 8. Assignment of Mortality Sink Distances to Roads Within and Adjacent to the Conservation Areas

Road	AADT* (2008)	Comparable To (von Seckendorff Hoff and Marlow 2002)	ADT† (1992)	Distance to 90% Asymptote
Gold Butte-Pakoon				
Interstate 15	22,000	U.S. Route 95 (4-lane highway)	5,210	4,250 m
State Route 170	198	State Route 165 (2-lane highway)	220	2,250 m
Paved roads in the vicinity of Scenic, Arizona	Unknown	State Route 165 (2-lane highway)	220	2,250 m
Graded roads	Unknown	BC1 (graded road)	Unknown	1,400 m
Superior-Cronese				
Interstate 15	37,500 – 70,000	U.S. Route 95 (4-lane highway)	5,210	4,250 m
Fort Irwin Road	3,908	State Route 163 (4-lane highway)	4,610	2,650 m
State Route 58	11,000	State Route 163 (4-lane highway)	Unknown	4,250 m
Old Highway 58	Unknown	State Route 165 (2-lane highway)	Unknown	2,250 m

* Annual average daily traffic
† Average daily traffic

Railroads

Impacts

Railroads are similar to roads as sources of mortality for desert tortoises because tortoises can become caught between the tracks, causing them to overheat and die or be crushed by trains (USFWS 2008a). Because of this, railroads are likely significant barriers to tortoise dispersal, and may contribute significantly to habitat fragmentation.

Cumulative and Interactive Effects with other Threats

Because railroads are linear features that are often constructed near other linear features, such as roads and utility corridors, this threat can contribute in a cumulative fashion to limit tortoise dispersal across these barriers. Barriers to movement and population connectivity also have implications to exchange of genetic material, which can lead to inbreeding, and may result in eventual mortality of individuals (Boarman and Sazaki 1996). Railroads likely contribute to the spread of invasive plants, and contribute to the deposition of toxins and pollutants, and poor air quality.

Distribution within Conservation Areas

The Burlington Northern Santa Fe railroad crosses through the southern portion of the Superior-Cronese Conservation area, near Interstate 15 and California Highway 58 and utility corridors that include natural gas pipeline and electric transmission line corridors (Figure D-5 in Appendix D). The culmination of these linear features creates a highly fragmented landscape. This railroad was in existence throughout the entire period of study, and we detected no change associated with it using remote sensing. We predicted tortoise mortality sinks adjacent to railroads by assuming that this railroad contributes to mortality of desert tortoises in a manner similar to a 2-lane paved highway and placing a 2,250 m buffer along the railroad corridor (Figure E-15 in Appendix E). There are no railroads within the Gold Butte-Pakoon Conservation Area.

Utilities

Electric transmission lines, fiber optic cables, and pipelines carrying various liquids and gasses cross great distances through the desert. Utility lines are typically within a right-of-way or utility corridor, and the direct impacts associated with these linear corridors are similar to those exhibited by roads, including habitat fragmentation, tortoise mortality, edge effects and associated changes to vegetation communities, spread of invasive and predatory species, and opportunities for increased human access to otherwise remote areas (see Roads section). This section describes specific impacts that utility corridors have on desert tortoise habitat fragmentation, tortoise mortality, and spread of invasive and predatory species.

Impacts

Mortality

Minimization measures enacted during construction projects mitigate take of tortoises; as a result, construction activities have relatively low potential to result in direct mortality. However, certain types of construction projects appear to result in greater take of tortoises than others. Olson (1996) compared various linear utility construction projects of similar lengths and locations, and determined that the number of tortoise mortalities on a natural gas pipeline project (n=29) was substantially more than mortalities on a fiber optic line installation project (n=1) and a transmission line construction project (n=3). Olson (1996) determined that the increased mortality events on the natural gas pipeline project were the result of increased traffic and desert tortoise-vehicle collisions associated with a higher rate of transport of building materials in support of this project. Tortoise mortality associated with utility corridors may also occur during maintenance of the utilities, as well as from tortoise–vehicle collisions along utility access roads. During the construction of pipelines, trenches opened for the placement or maintenance of pipes may serve as traps for tortoises and other animals (Olson et al. 1993). Construction and maintenance of utility lines and associated facilities may also cause direct mortality of tortoises from construction vehicles or through the crushing of tortoises within burrows. Additionally, the foundations of utility structures and road cuts associated with utility infrastructure such as transmission towers or wind turbines may provide burrowing opportunities for desert tortoise, placing them at risk of harm during maintenance operations, the construction of new pipelines or power lines adjacent to existing corridors, or from road traffic along access roads. A study conducted at the Mesa wind park in the San Bernardino Mountains demonstrated that desert tortoise burrows were commonly associated with anthropogenic features in the landscape, such as road cuts and concrete pads supporting electrical equipment (Lovich and Daniels 2000).

Habitat Fragmentation

The addition of parallel lines to existing corridors may magnify the degree of habitat fragmentation, potentially influencing population viability by reducing the exchange of individuals between subpopulations (Edwards et al. 2004). Because it is favorable, in many cases, to construct new transmission lines adjacent to existing ones, these corridors can become increasingly wide, and thus in turn can create large areas of disturbance that represent low-quality habitat or mortality sinks. Barriers to movement and population connectivity also have implications to exchange of genetic material, which can lead to inbreeding, and may result in eventual mortality of individuals (Boarman and Sazaki 1996).

Facilitation of Human Access to Desert Environments

Access roads and disturbed rights-of-way provide sources of human access to desert areas. These roads are often traversed by OHV users, which represent another potential source of tortoise mortality through desert tortoise–vehicle collisions and which may further diminish the recovery of the habitat in and adjacent to the rights-of-way (see additional explanation of these impacts in the Roads and OHV sections).

<u>Cumulative and Interactive Effects with other Threats</u>

Subsidized Predators

Utility structures may also help facilitate nesting by ravens and subsequent predation of tortoises if those areas did not have adequate nesting substrates before the new towers were erected (Boarman 1993). Juvenile tortoise remains have been detected underneath transmission tower sites; the predation event was linked to ravens (McCullough Ecological Systems 1995). Additional impacts of ravens on desert tortoises are discussed in the Subsidized Predators section.

Invasive Plants

Long-term impacts to habitat (e.g., vegetation communities) can result due to the siting of utility facilities in tortoise habitat. Disturbances caused by grading and site preparation activities, as well as grading of access roads, provides a conduit for exotic invasive plants that may be brought in on construction equipment (Zink et. al. 1995). These non-native plant species, in turn, may reduce the available forage for tortoises or may be more prone to wildfire than typical desert plant species. Additional impacts of invasive plants on desert tortoises and their habitat are discussed in the Invasive Plants section.

Other Cumulative and Interactive Threats

Utilities originate from, or traverse urbanized areas, and access roads are a ubiquitous feature of both linear utility corridors and point utility facilities. Linear utilities are often associated with other linear features, including roads and railroads. Cumulatively, linear corridors that contain several features (e.g., roads, utility corridors, railroads, etc.) can act to fragment desert habitats more dramatically by creating more effective barriers to tortoise dispersal. Access roads associated with utility features facilitate OHV use, collection and poaching of tortoises, and illegal dumping. Finally, construction and maintenance of utility facilities my introduce litter, toxins, and pollutants into adjacent desert environments.

<u>Distribution within Conservation Areas</u>

There are no utility corridors within the Gold Butte-Pakoon Conservation Area, but several communication towers are distributed within and adjacent to the Conservation Area (Figure D-6 in

Appendix D). Most of these utilities are associated with access roads that terminated at the utility location.

Six electric transmission corridors and three natural gas pipeline corridors run through the southern parts of the Superior-Cronese Conservation Area near Interstate 15, California Highway 58, and the Burlington Northern Santa Fe Railroad (Figure D-7 in Appendix D). Most utility corridors observed in the Conservation Area are associated with access roads or trails, and several are arranged in corridors that contain other linear features such as highways or railroads. Other utilities observed within the Conservation Area include communication towers and other utilities distributed at discrete point locations. Most of these utilities are associated with access roads that terminated at the utility location. Using remote sensing techniques, we detected the timing of the construction or expansion of transmission corridors within the Superior-Cronese Conservation Area. Two of the electric transmission rights-of-way have widened substantially since 1990 (Figure 10; Figure E-16 in Appendix E).

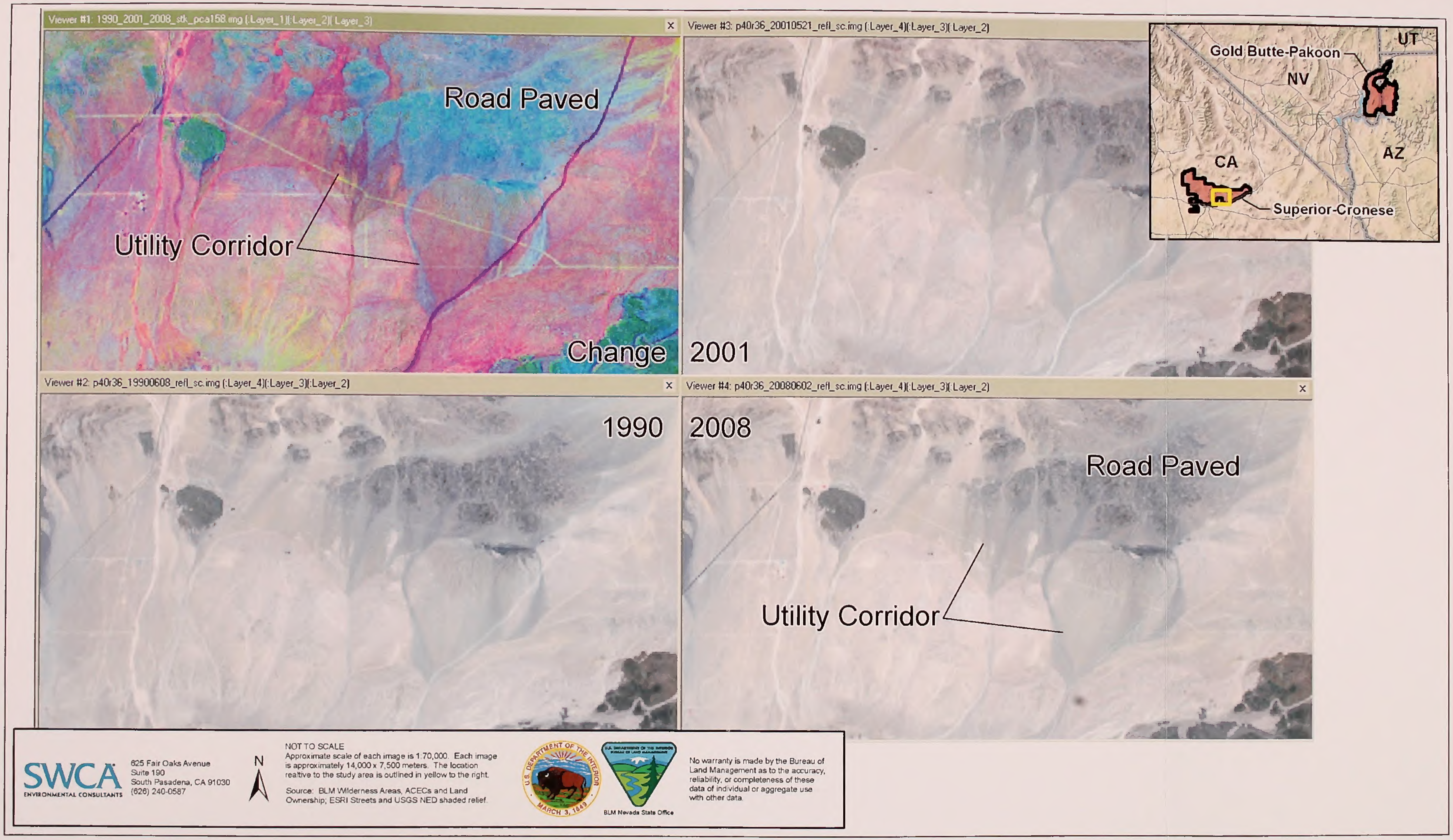

Figure 10. Remotely Sensed Road and Utility Corridors

The remotely sensed change image (upper left) shows several lighter feature representing vegetation removal sometime between 2001 (upper right) and 2008 (lower right). None of these disturbances were present in 1990 (lower left) imagery. The magenta features appear to indicate paving or other surface treatment of a road. The light green features appear to indicate the construction or expansion of utility corridors.

Landfills

Impacts

Landfill development results in the direct loss of desert tortoise habitat. In addition, edge effects are common along landfill boundaries, as habitats adjacent to landfills may become degraded through the spread of trash and invasive plants. Toxic chemicals may also be introduced into the environment as a result of dumping at landfills, and increased desert tortoise–vehicle collisions may result from traffic driving to or from the landfill along access roads (Boarman 2002a). Finally, construction of access roads may contribute to habitat fragmentation, and the spread of invasive plants and subsidized predators.

Cumulative and Interactive Effects with other Threats

Subsidized Predators

Boarman (2002a) states that landfills probably have the greatest potential impact on desert tortoises through the role that they play in facilitating increased predation by ravens and possibly coyotes. Several studies document the use of landfills by ravens. Kristan and Boarman (2003) estimated that raven population densities within a 770 km^2 area in the Western Mojave Desert were highest at the Edwards Air Force Base housing area and landfill, the Mojave Landfill, and man-made ponds. Boarman et al. (1995) provide a more detailed raven population study on the Edwards Air Force Base, and indicated that ravens used landfills more than any other resource type in the study (golf courses, sewage ponds, city streets, and open desert). Boarman et al. (1995) observed that 90% of telemetered raven relocations were within 4.46 km of anthropogenic resource subsidies (landfills) in the west Mojave Desert. The abundant food source provided by landfills likely allows raven individuals to survive in areas where natural sources of food are otherwise low in abundance, particularly during the summer and winter seasons (Boarman 1993). A constant food source also may result in a higher rate of successful breeding of ravens, which in turn may result in increased risk of raven-induced morality to juvenile tortoises. Kristan and Boarman (2003) estimated the probability of attack on tortoises nearing 100% among the largest raven groups at landfills. A more detailed description of the impacts of ravens on desert tortoises is discussed in the Subsidized Predators section.

Other Cumulative and Interactive Threats

Landfills are the location of the disposal of trash that originates from urban areas, and are often located a short distance from them. Landfills are accessed by roads; and litter, toxins, and pollutants originate from landfills. Construction and maintenance of landfills likely contributes to the spread of invasive plants.

Distribution within Conservation Areas

Within the Gold Butte-Pakoon Conservation Area, there is a landfill located at the end of Mesquite Heights Road, located northwest of the Conservation Area (Figure D-8 in Appendix D).

Numerous landfills are located within the Superior-Cronese Conservation Area. Two landfills are located in the northwest portion, and seven other landfills are distributed within the southern portion of the Conservation Area (Figure D-9 in Appendix D). Eighteen additional landfills are located within three miles of the Conservation Area boundaries. The Lenwood Landfill, located in the southeastern portion of the Conservation Area, was closed in 1997 and capped in subsequent years, which we detected using remote sensing techniques (Figure E-17 in Appendix E). Several landfills in the West Mojave Desert are slated to be closed and converted to transfer or community collection stations (Boarman 2002a). It is unclear which, if any, of these are located in the Superior-Cronese Conservation Area; however, this could reduce the food source for ravens and other predators, thereby reducing pressure on adjacent desert

tortoise populations, but may increase the amount of traffic at these locations, thereby increasing the number of road kills (Boarman 2002a).

Anthropogenic Water Sources

Impacts

Anthropogenic water sources contribute to loss of tortoise habitat, and may contribute to degradation of adjacent desert habitats through the facilitation of the spread of invasive plants.

Cumulative and Interactive Effects with other Threats

Subsidized Predators

Water sources are scarce and ephemeral in undeveloped areas of the desert, and desert wildlife population sizes are likely limited by their availability. Recent human population growth and development in desert areas have provided certain desert wildlife with numerous anthropogenic sources of water, including sewage settling ponds, irrigation ponds, stock tanks, ornamental ponds (e.g. golf course ponds), and cooling ponds. In particular, the development of man-made sources of water may facilitate higher raven populations by providing water during periods of low availability, and allowing ravens to expand their range into parts of the desert that are isolated from natural sources of water. Ravens are known to utilize a wide variety of anthropogenic food and water sources, and which may subsidize their population growth, thereby increasing predation pressures on local desert tortoise populations (Boarman 1993, Kristan 2001, Sherman 1993, Boarman 2003). Water sources are eagerly sought by ravens, and sources as small as puddles beneath leaking faucets are known to be major attractants to ravens when they are in close proximity to other existing food subsidies such as landfills (Sherman 1993 in Boarman 2003). Raven nests are most common near anthropogenic sources of food or water and near roads, and to decline in abundance with increasing distance from either (Kristan 2001). In general, ravens selected nest sites within 2 km of point subsidies, and avoided areas that were over 2 km from point subsidies (Kristan 2001). Sherman (1993, in Boarman 2003) reported that nesting ravens left their territories daily to drink water 'several' kilometers away. Boarman et al. (1995) observed that 90% of telemetered raven relocations were within 4.46 km of anthropogenic resource subsidies (landfills) in the west Mojave Desert – a pattern that may be inferred for anthropogenic water resources.

Other Cumulative and Interactive Threats

Anthropogenic water sources are most often associated with urbanized areas, but are also a feature of mining activities, particularly leachate ponds. Anthropogenic water sources are also associated with livestock grazing (stock tanks) and agricultural activities (irrigation). Military activities may provide additional sources of water. Finally, anthropogenic water sources facilitate the spread of invasive plants.

Distribution within Conservation Areas

There are several anthropogenic water sources within and adjacent to the Gold Butte-Pakoon Conservation Area, including numerous ponds in the vicinity of Mesquite, and Lake Mead situated along the southern and southeastern portions of the Conservation Area (Figure D-10 in Appendix D). Anthropogenic water sources within and adjacent to the Superior-Cronese Conservation Area include several ponds, generally associated with human developments within and adjacent to the southern boundary of the Conservation Area (Figure D-11 in Appendix D).

3.3.2 Human Actions and Activities

Off-highway Vehicle Use

The impacts of OHV use on desert landscapes and communities has been well-documented, as studies have documented their effects on soils, watersheds, water quality, air quality, vegetation, and wildlife (see review in Ouren et al. 2007). This section describes impacts to desert tortoises by motorized activities associated with off-road travel, specifically addressing travel on single- or double-track trails, unauthorized trails, within washes, and cross-country travel (i.e., the effects of OHV use on graded roads is considered in the Roads section).

The BLM (2006) defines an OHV as "any motorized vehicle capable of—or designated for—travel on or immediately over land, water, or other natural terrain." Cordell et al. (2005) provide additional descriptions of OHVs, indicating that they may include motorcycles and off-highway motorbikes, all-terrain vehicles, dune buggies, most four-wheel-drive automobiles (jeeps, sport utility vehicles), and any other civilian vehicle specifically designed for off-road travel.

Boarman (2002) describes four types of OHV activities, including: 1) "free play," the unrestricted use of areas beyond designated routes and where off-trail activity likely occurs regularly; 2) "non-competitive recreational uses outside of free play areas," where activities are limited to designated roads and trails; 3) "competitive events," which include organized races in which travel is restricted to designated open areas; and 4) unauthorized cross-country travel. The type of trail created by OHV activity is also dependent on the intensity of use and location of activity. Matchett et al. (2004) classify OHV routes as either dirt routes, in which travel routes were likely created for or by OHV use, or as wash routes, in which travel routes were most likely created by water flow but were likely subjected to OHV activity. They also note that OHV use may be heaviest on slopes, along rights-of-way, in washes, and in the vicinity of camping facilities.

Although there have been numerous reviews on the ecological effects of OHV activities on wildlife (see Bury et al. 1977; Berry 1980; Brattstrom and Bondello 1983; Luckenbach and Bury 1983; Webb and Wilshire 1983a; and Brooks 1999a), the following discussion focuses on the effects of OHV activities on desert tortoise.

<u>Impacts</u>

Mortality

Researchers have documented that OHV use results in direct mortality to desert tortoises through collisions on the soil surface or by being trapped within burrows collapsed by OHVs (Bury et al. 1977; Berry 1980; Bury 1980; Burge 1983; Luckenbach and Bury 1983; Berry and Nicholson 1984a; Bury and Luckenbach 1986; Berry 1992; Brooks 1999a; Lovich and Bainbridge 1999; Grant 2005). Berry (1980a) reported a relationship between OHV activities and desert tortoise population declines, and other researchers have documented declines in reptilian wildlife populations in areas frequented by OHV users compared to undisturbed areas (Bury et al. 1977; Berry 1980; Bury 1980; Luckenbach and Bury 1983; Brooks 1999a; Grant 2005). OHV-tortoise collisions and destruction of burrows by OHV activities is exacerbated because tortoises spend a significantly greater amount of time (e.g., foraging, burrowing, traveling) in washes, washlets, and on small hills (Jennings 1997), areas that represent potential, and often preferred, travel routes for OHV users (Bury and Fillmore 1974), particularly if these areas are off-trail (Fisher et al. 2001).

Habitat Loss and Degradation

OHV activity affects soils through the alteration of soil structure; the destruction of biotic soil crusts, abiotic soil crusts, and fine gravel surfaces that would otherwise stabilize soils; and soil erosion. These factors ultimately contribute to soil compaction (Liddle 1997). Soil compaction is a common problem throughout the desert and is primarily caused by vehicles traveling across the desert surface (Webb 1982). In undisturbed conditions, soils typically have a high porosity and low bulk density (Froehlich et al. 1985). OHV travel has some effect on soil strength, which is affected by compaction, moisture content, texture, and bulk density (Adams et al. 1982a). These effects are primarily due to the disruption of the crust and vesicular layer (Webb 1982), whereby compacting the soil makes it less porous, thus making it more vulnerable to water and wind erosion (Iverson et al. 1981; Lovich and Bainbridge 1999).

The initial effects of soil compaction are obvious; however, the impacts can persist for years, even centuries, after the initial disturbance (Webb and Wilshire 1980; Webb 1982; Froehlich et al. 1985; Prose 1985; Lovich and Bainbridge 1999). Webb (1982) noted that although a single-pass trail could be faintly seen even a year after impact, there was a slight increase in surface gravel and annual plant growth in the trail. Webb (1982) also reported that multiple-pass trails (100 and 200 passes) exhibited visible side berms. In more extreme cases, soil-loosening processes many take decades (or even centuries) to eliminate compaction, as soil resistance on previously disturbed military grounds was more than 50% greater than that of undisturbed soils (Prose 1985).

OHV activity can accelerate the erosion process due to the reduction in vegetative cover, water infiltration, and loss of soil-stabilizing crusts (Webb et al. 1978; Iverson et al. 1981; Webb 1982; Wilshire 1983b). In fact, the yearly Johnson Valley–Parker off-road vehicle race (1980–1983) resulted in soil compaction that destroyed a 2- to 5-cm-thick vesicular A soil horizon and the desert pavement surfaces, and caused the excavation (mechanical erosion) of the A and B soil horizons to depths of 20 cm (Wilshire 1983b). Typically, only a few passes over the surface are needed before impacts are recognized. Cole (1990) recorded soil crusts destroyed by only 15 passes by hikers wearing lug-soled boots. Travel routes with a single-vehicle pass had soil strengths 5.3 to 28.4 kg/cm^2 (depending on the percentage of soil moisture) greater than undisturbed soil (Adams et al. 1982a), indicating that just a single pass can begin to affect soil strength. Webb (1982) recorded changes to the surface after 1, 10, 100, and 200 motorcycle passes and found that the 1-pass trail had a slight surface indentation with knob imprints from the tires. Although most of the initial impacts are seen after the first few passes, the effects of subsequent passes are more severe. As the number of vehicle passes increases, soil density increases and the infiltration rate decreases (Lovich and Bainbridge 1999). Iverson et al. (1981) found that soil bulk density increased logarithmically with the number of vehicle passes. A study by Webb (1982) determined that 100- and 200-pass trails had berms and lateral edges present, and the centers of the trails were 10 to 30 mm below the level of undisturbed soil adjacent to the trail. Mean soil strength on trails with 10 and 20 passes was too high to measure (Adams et al. 1982a). Stabilizing crusts may take 300 to 500 years per inch to replace (Hudson 1971).

Wind erosion may also indirectly increase the amount of debris flow (Lovich and Bainbridge 1999), which has been documented to bury plants at distance beyond that of the area affected (Nakata 1983). Along heavily traveled roadways in Alaska, Walker and Everett (1987) found dust impacts up to 10 meters from the side of the road and dust blankets up to 10 cm on mosses and low-growing vegetation. Several morphological factors contributed to plant susceptibility to heavy dust load accumulations, including mat or prostate growth form, lack of a protective stem cortex or leaf cuticle, blocked stomata, cell destruction, and intricate branching or closely spaced leaves that tend to trap dust (Walker and Everett 1987; Spellerberg and Morrison 1998). Fugitive dust created by OHV use can disrupt photosynthetic processes, which in turn have the potential to suppress plant growth (Walker and Everett

1987; Spellerberg and Morrison 1998). Other processes that may be affected by dust include respiration and transpiration (Spellerberg and Morrison 1998).

Many of the indirect effects of OHV activities on vegetation are closely tied to soil properties altered by OHV traffic. These indirect effects include the creation of edge habitats, increased levels of airborne pollutants, and dust raised by OHV use (see discussion in Roads section). Direct impacts to vegetation include the crushing of plants by OHV use.

Soil compaction results in the inhibition of plant roots to penetrate to deeper soil levels. The increase in soil compaction decreases the soil's ability to support vegetation through the inhibition of root growth and water infiltration (Hinckley et al. 1983). Adams et al. (1982b) observed plant cover within tracks made by 1, 3, 10, and 20 vehicle passes, and concluded that the cover of annuals with large taproots decreased, whereas a non-native grass with a fibrous root system showed significantly greater cover. This impermeable nature of soil surfaces exposed to OHV activities creates small microhabitats that can be readily colonized by invasive plant species, as compacted routes shed precipitation and in turn effectively increase the overall moisture availability within the dirt track or along the trail shoulder. The soil disturbances caused by OHV use also removes or prevents the establishment of native vegetation, and is conducive to the establishment of invasive plant species (Boarman 2002; Brooks and Pyke 2002; Brooks and Berry 2006; Jennings 1997). Davidson and Fox (1974) found non-native, early successional species were common at sites disturbed by OHV use, and in a comparison of OHV-disturbed plots and non-disturbed plots, Brooks (1995) found that the common Mediterranean grass was the only species with greater biomass in the OHV-disturbed plots.

Vegetation is also negatively affected through the direct crushing of plants by OHV activities, resulting in reduced vegetative cover (Adams et al. 1982b; Webb 1983; Prose et al. 1987; Bolling and Walker 2000). Webb (1983) found that annual plants remained intact after a single pass by an OHV; however, most plants were destroyed after only 10 passes. Similarly, Groom et al. (2005) determined that the federally listed Peirson's milkvetch (*Astragalus magdalenae peirsonii*) was more likely to occur at locations in which OHV activity was restricted, rather than at locations in which OHV activities were rested. Several OHV races have been determined to negatively affect vegetation along the race routes (Davidson and Fox 1974; BLM 1975; Burge 1983; Woodman 1986). The loss of plants and grasses identified as being important to desert tortoises and which have been documented as affected by OHV activities have also been reported by Wilshire (1979) and Bury and Luckenbach (1986).

Habitat Fragmentation

Brooks and Lair (2005) state that the cumulative impacts of any single OHV track at multiple locations across the landscape can cumulatively result in impacts that could influence wildlife species at much greater scales. For example, a single OHV pass across the landscape is likely to have negligible effects on animal distributions; however, if that action is reciprocated and becomes intensive throughout multiple sites across the landscape, animal densities may experience declines (Reijnen et al. 1995; Reijnen et al. 1997). These networks of OHV routes, when dispersed across large areas, may therefore impair the ability of wildlife species to navigate landscapes (Forman et al. 2003), particularly when the indirect impacts associated with OHV activities may extend well beyond the actual footprint of disturbance.

A study by Bury and Luckenbach (2002) highlights the effects that OHV activities have on desert tortoise habitat, abundance, and life history features. Plots in non-OHV areas exhibited 1.7 times more live plants, 3.9 times more plant cover, 3.9 times more desert tortoises, and 4.0 times more active tortoise burrows than in plots on a nearby area used heavily by OHVs. Although perhaps not a direct measure of habitat fragmentation, the impacts of OHV activities on tortoise habitat were clear, and indicate that habitat connectivity could be impaired through the proliferation of intensive OHV use across the landscape.

Similar trends in tortoise densities relative to OHV areas were reported by Berry et al. (1996), who reported that tortoise population densities were lower in areas where OHV trails were higher in density.

Facilitation of Human Access to Desert Environments

Recreational OHV use, by its very nature, facilitates human access to desert environments. OHV users typically recreate in groups and camp in the desert on extended recreation forays, further intensifying the effects of human activity in desert environments.

Cumulative and Interactive Effects with other Threats

Pollutants and Air Quality

Many of the small engines associated with various types of OHVs, especially two-stroke models, do not burn fuels completely and produce emissions that are the result of incomplete combustion. These emissions include aldehydes, carbon monoxide, nitrogen oxides, ozone, sulfur dioxide, and polycyclic aromatic hydrocarbons. OHV emissions also contain various heavy metals, including zinc, copper, nickel, chromium, and lead (National Research Council 1986), the latter of which was a significant contributor to emissions prior to the ban on leaded gasoline in 1996. Despite the ban on this heavy metal and its decline in emissions since control policies were implemented in the 1970s, it may still be present in many soils exposed to high areas of motorized vehicle travel, particularly OHV areas, and can continue to affect soil, water, air, and plant resources if contaminated soils are dislodged (Forman et al. 2003). Direct impacts of pollutants emitted from OHVs on tortoises are largely unknown.

Other Cumulative and Interactive Threats

OHV users typically enter desert environments from urbanized areas, and travel along roads that access desert areas, including those access roads associated with utilities, landfills, and mines. Travel along these roads and within desert habitats increases the likelihood of OHV users collecting tortoises for pets. OHV users frequently camp in natural areas, and likely contribute to the spread of garbage and litter in the camp vicinity. The trash left by camping OHV users likely attracts subsidized predators. Soil disturbances caused by OHV use likely contributes to the spread of invasive plants. OHV use can also contribute to the threat of fire if hot engine parts come into contact with dried vegetation.

Distribution within Conservation Areas

Heaton (2007) describes the spatial distribution of various types of roads within multiple desert tortoise study areas, including the Superior-Cronese and Gold Butte-Pakoon Conservation Areas. This GIS analysis determined that activities resulting in high numbers of single-track single-pass roads were almost exclusively restricted to the Western Mojave Recovery Unit, including the northwest and southeast portions of the Superior-Cronese Conservation Area; no such trails were documented in the Gold Butte-Pakoon Recovery Unit. Similar patterns were evident for single-track multi-pass roads; however, the density of such tracks within the Superior-Cronese Conservation Area was much lower than the density of single-track single-pass roads. Within the Superior-Cronese Conservation Area, the combined data of all single-track roads, most likely illegal motorcycle activity, was highest along the west and south-central borders. Double-track multi-pass roads were highest within portions of the Fremont-Kramer, Superior-Cronese, Ord-Rodman, and Piute-Eldorado Conservation Areas; the north-central and south-central portions of the Superior-Cronese Conservation Area had the highest concentration of these tracks. The study determined that, with relatively few exceptions, all of the single-track and double-track roads (albeit to a lesser degree) were most likely the result of illegal off-road travel (regardless of the number of passes documented along those roads).

The BLM recognizes the threat that OHV use poses for desert tortoise, and has closed routes within the Conservation Areas in an effort to curb further degradation of desert tortoise habitat (Figures D-12 through D-15 in Appendix D). However, illegal OHV use along closed routes or in areas adjacent to existing trails continues to threaten desert tortoise habitat. Using remote sensing techniques, we examined the effect of illegal OHV use within desert tortoise habitat outside of designated routes. We detected numerous areas of vegetation change that could be attributed to this threat in both Conservation Areas (Figures E-3 and E-18 in Appendix D). One example from the Superior-Cronese Conservation Area is depicted in Figures 11 through 14. These figures show the gradual but pronounced loss of habitat in an OHV-closed area adjacent to a route that was open in 1987 (Figure 15) and closed to OHV use in 2001 (Figure 16). In another example from the Superior-Cronese Conservation Area, we detected a shifting and widening of washes, which we have confirmed was caused by OHV use within the drainages, and possibly followed by flash flood events that contributed to further erosion (Figure 17). Figures 18 through 20 show the gradual but pronounced loss/degradation of wash habitat due to OHV use.

We detected higher densities of OHV tracks within plots sampled on the OHV and Urban Treatment Areas in the Gold Butte-Pakoon Conservation Area compared to those within other treatment areas (see Table 5).

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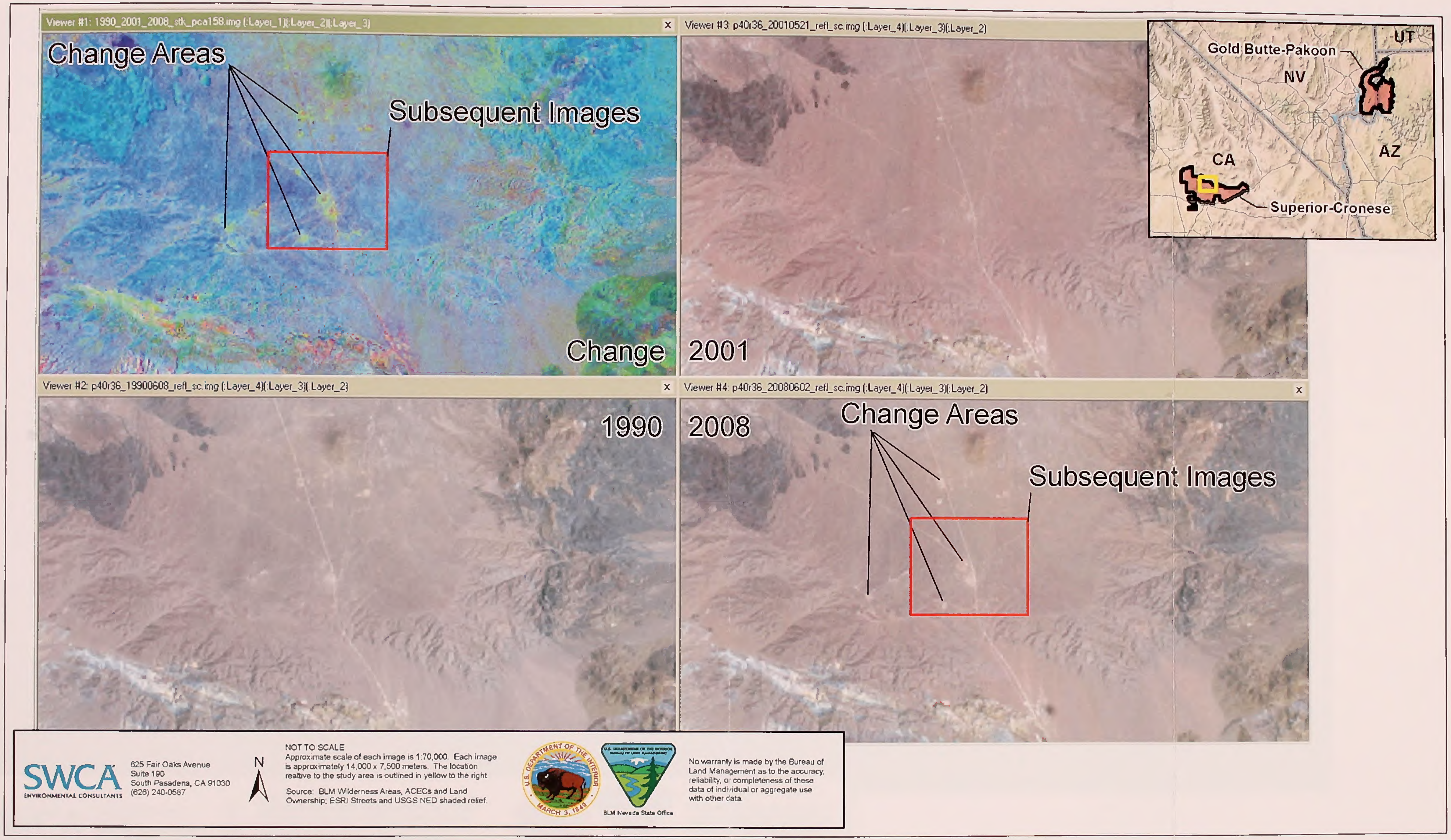
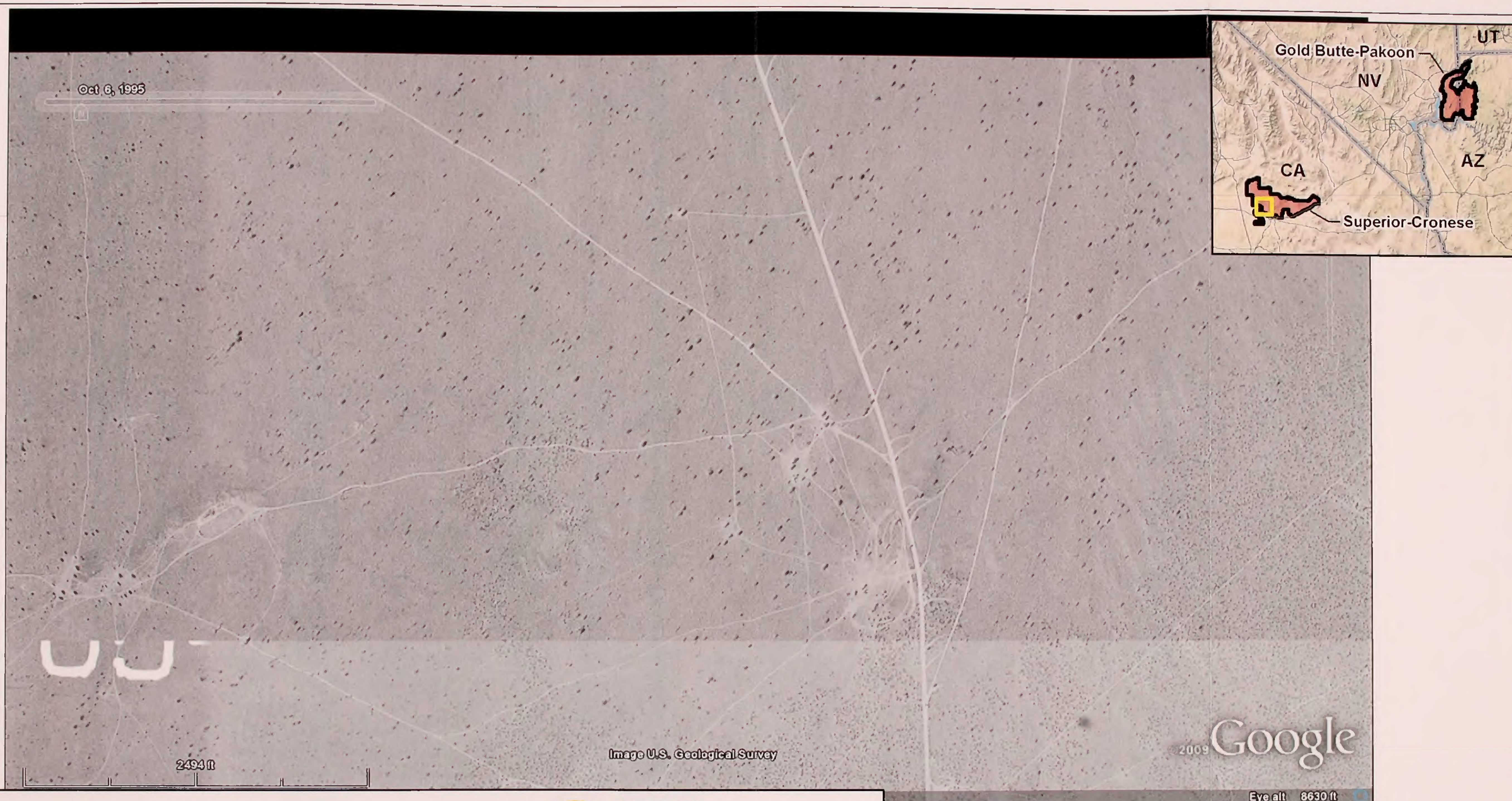


Figure 11. Remotely Sensed OHV Use

The remotely sensed change image (upper left) shows several red and light green areas from the Superior-Cronese Conservation Area that represent vegetation removal and exposed soil. These changes continued to occur from 1990 (lower left) through 2001 (upper right) and 2008 (lower right). As depicted in the following series of aerial photos, these areas experienced expanded off-road vehicle use.



SWCA ENVIRONMENTAL CONSULTANTS

625 Fair Oaks Avenue
Suite 190
South Pasadena, CA 91030
(626) 240-0587

N

NOT TO SCALE
Approximate scale of each image is shown. The location realtive to the study area is outlined in yellow to the right.

Source: BLM Wilderness Areas, ACECs and Land Ownership; ESRI Streets and USGS NED shaded relief.

BLM Nevada State Office

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data of individual or aggregate use with other data.

Figure 12. Aerial Image from 1995 Showing Area of OHV Use

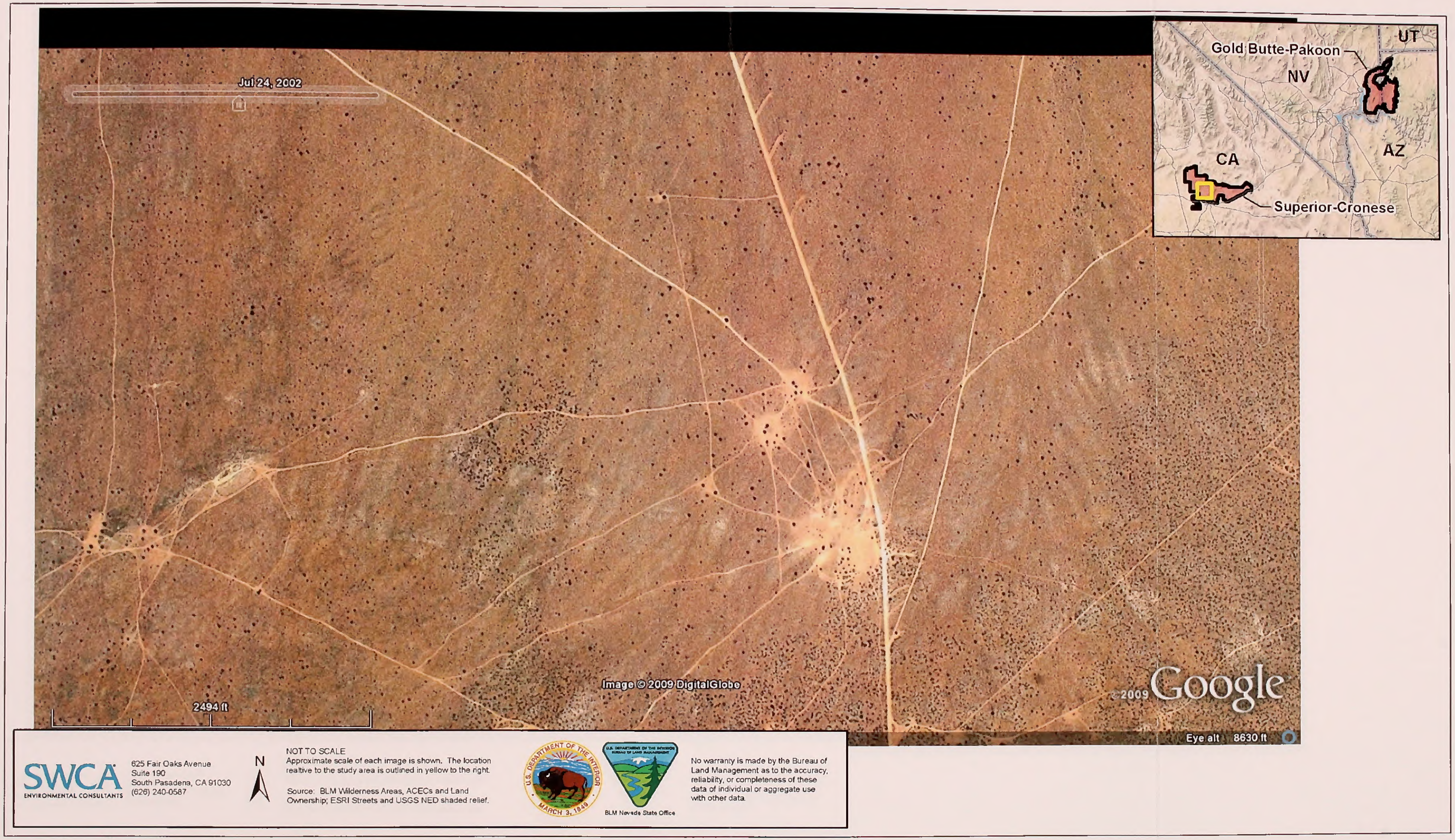


Figure 13. Aerial Image from 2002 Showing Area of OHV Use

This image depicts increased intensity of OHV use and the result in change to vegetation cover.

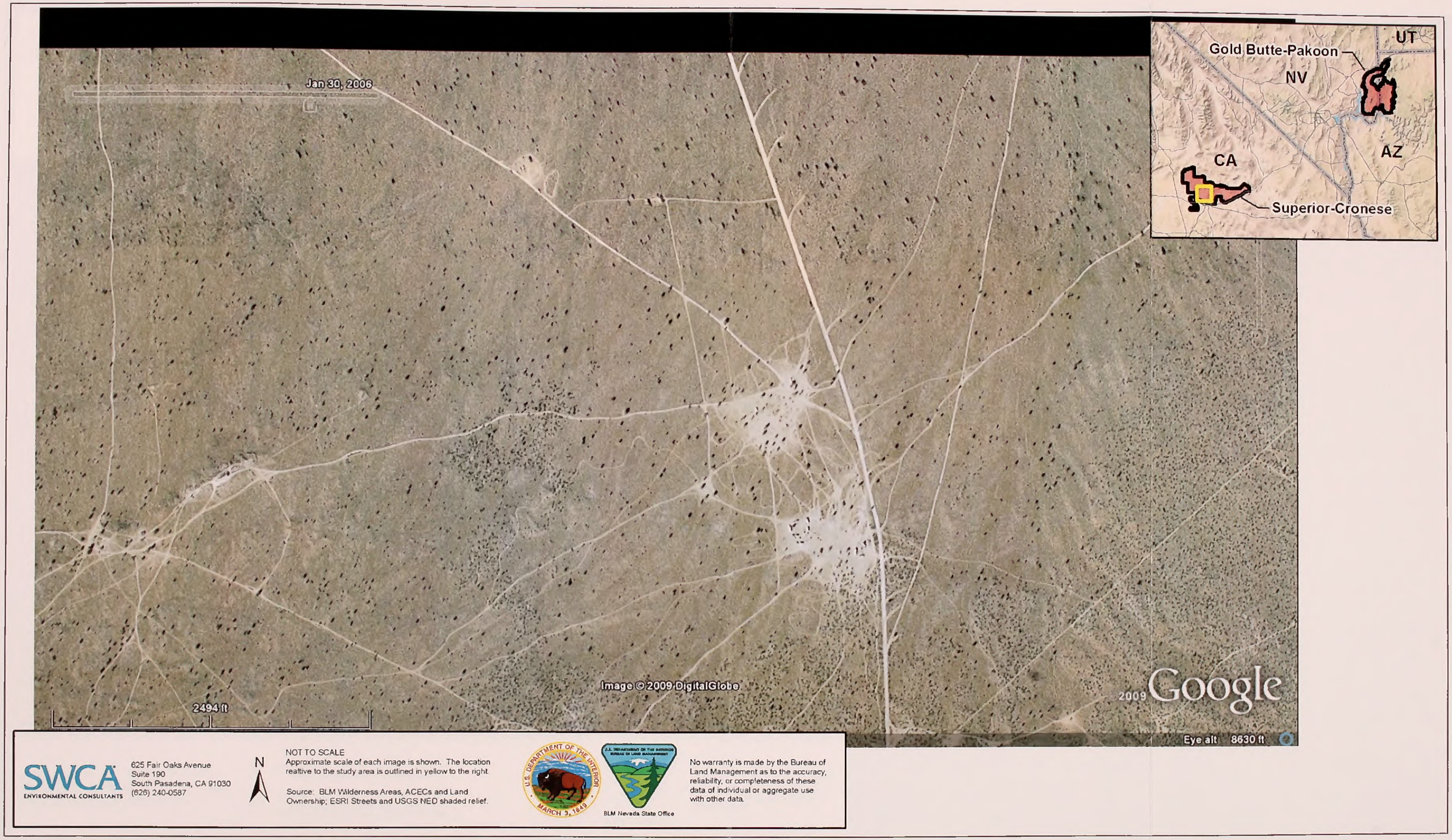


Figure 14. Aerial Image from 2006 Showing Area of OHV Use

This image depicts increased intensity of OHV use and the result in change to vegetation cover.

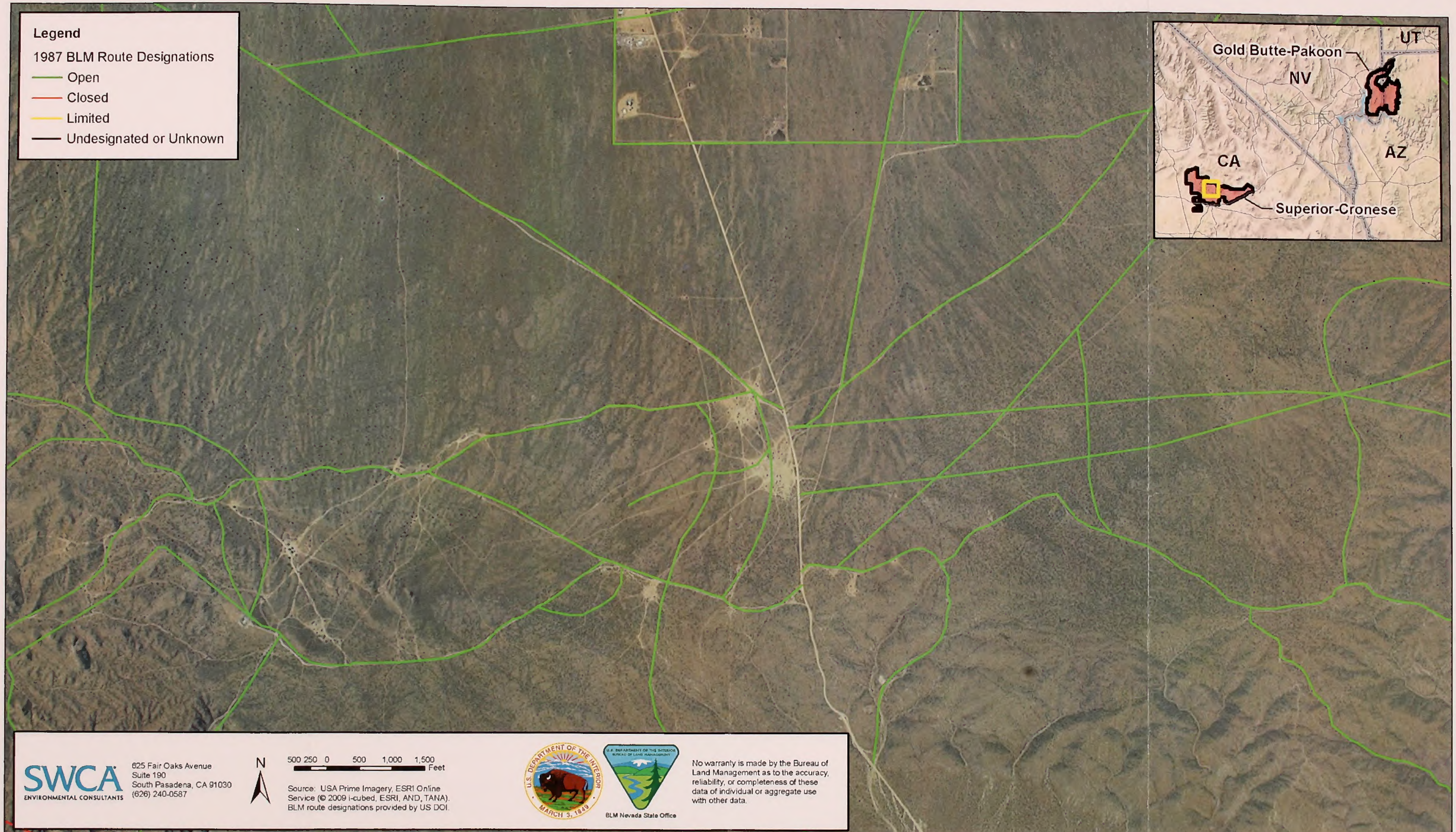


Figure 15. 1987 Route Designations in the Vicinity of the OHV Area

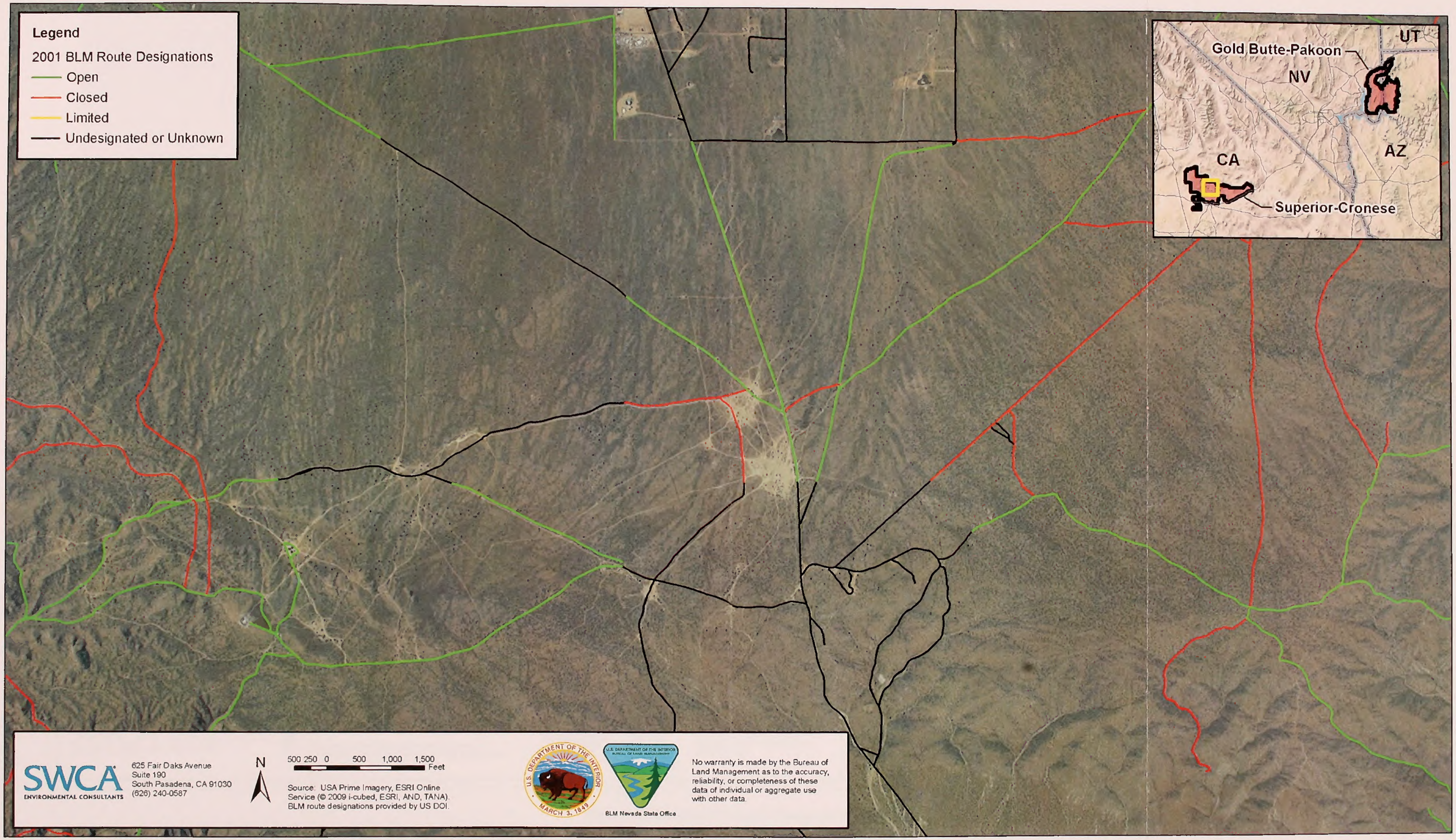


Figure 16. 2001 Route Designations in the Vicinity of the OHV Area

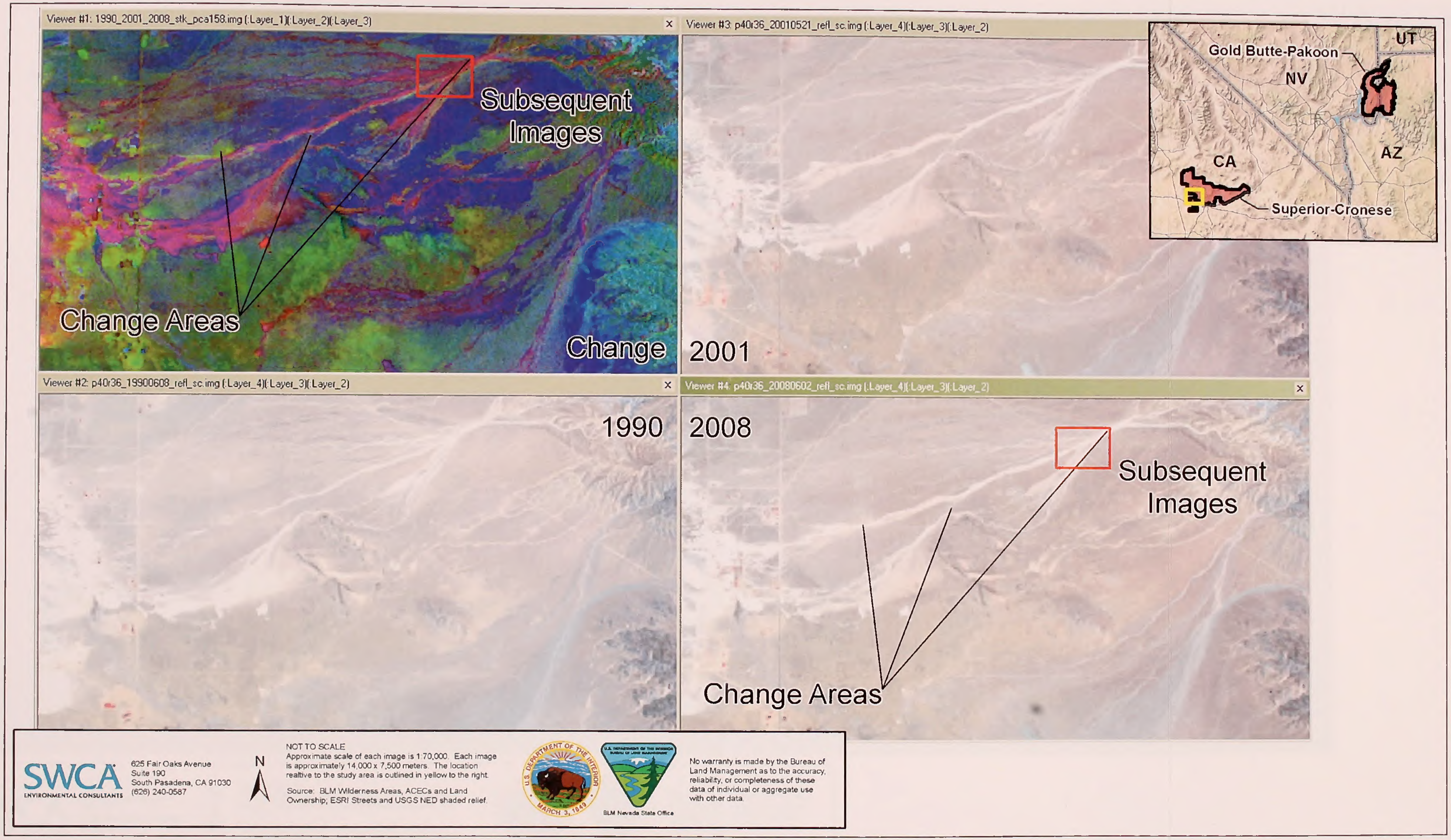


Figure 17. Remotely Sensed Change in Washes

The remotely sensed change image (upper left) depicts vegetation removal and erosion within washes (magenta and green areas) between 1990 (lower left), 2001 (upper right), and 2008 (lower right). Some of the changing wash patterns were pronounced along roadways and where trails intersect the washes, possibly indicating change due to OHV use and habitat degradation within the washes, followed by hydrological erosion events.

SWCA ENVIRONMENTAL CONSULTANTS
625 Fair Oaks Avenue
Suite 190
South Pasadena, CA 91030
(626) 240-0587

N

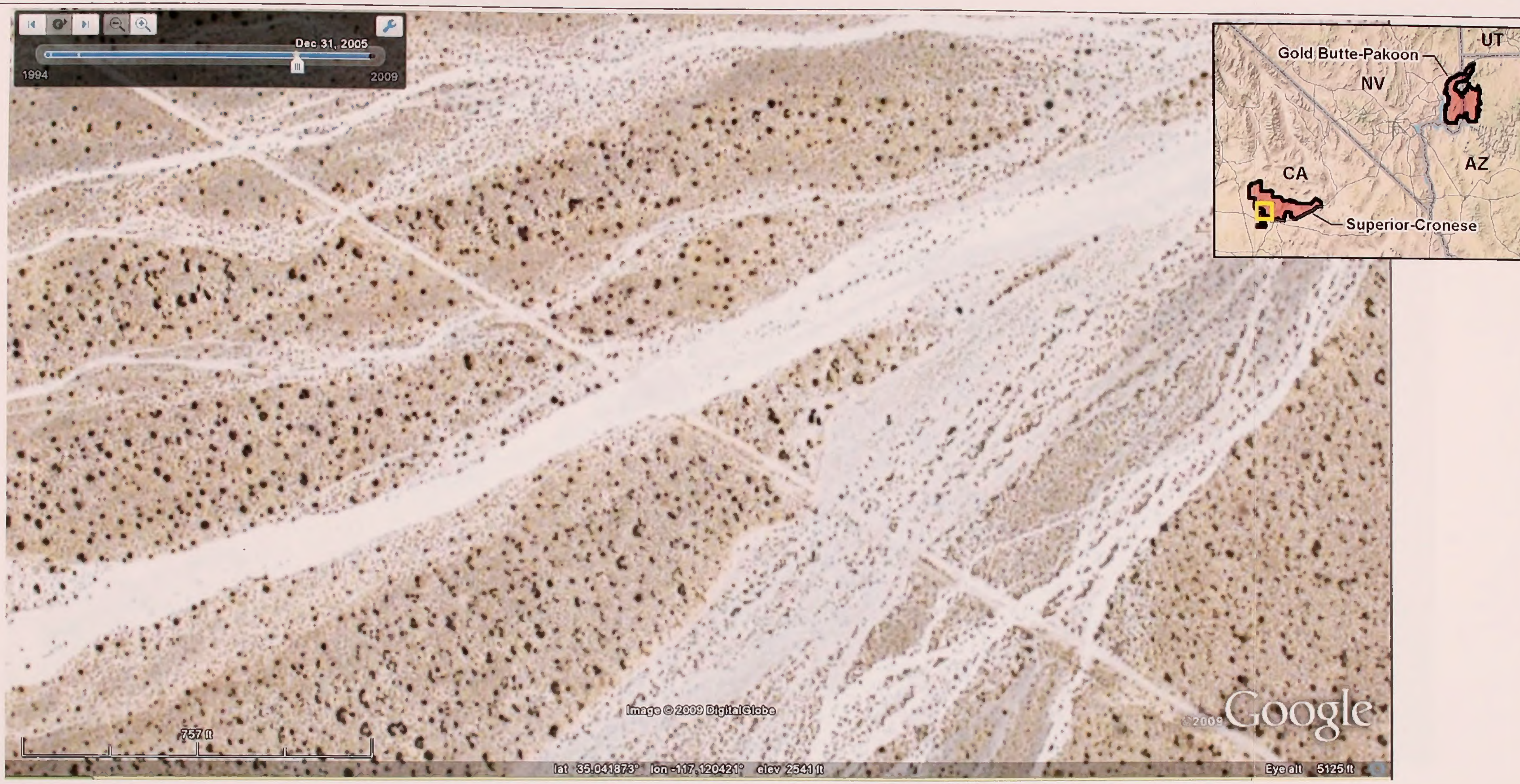
NOT TO SCALE
Approximate scale of each image is shown. The location realtive to the study area is outlined in yellow to the right.

Source: BLM Wilderness Areas, ACECs and Land Ownership; ESRI Streets and USGS NED shaded relief

BLM Nevada State Office

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data of individual or aggregate use with other data.

Figure 18. Aerial Image from 1995 Showing Area of OHV Use



SWCA ENVIRONMENTAL CONSULTANTS
625 Fair Oaks Avenue
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(626) 240-0587

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Source: BLM Wilderness Areas, ACECs and Land Ownership; ESRI Streets and USGS NED shaded relief.

BLM Nevada State Office

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data of individual or aggregate use with other data.

Figure 19. Aerial Image from 2005 Showing Area of OHV Use

This image depicts increased intensity of OHV use and the result in change to vegetation cover.

Figure 20. Aerial Image from 2006 Showing Area of OHV Use

This image depicts increased intensity of OHV use and the result in change to vegetation cover. The red circle indicates the location of an OHV-users' camp within the wash.

Livestock Grazing

The USFWS (1994a) considers domestic livestock grazing (including grazing by domestic cattle, horses, and sheep) and grazing by wild burros and horses to be a threat incompatible with desert tortoise recovery. Livestock grazing (primarily cattle and sheep) has occurred in desert tortoise habitat since the 1850s (Berry 1978; BLM 1995). In the 1800s, livestock numbers in Mojave were high and unregulated, but the Taylor Grazing Act of 1943 initiated grazing management and began reducing livestock numbers (Bostick 1990; Lovich and Bainbridge 1999; Oldemeyer 1994). Despite this regulation, continued grazing has altered the desert ecosystem. Conclusions about the degree of effects of grazing on arid ecosystems have been contradictory and controversial; however, the effects of overgrazing on rangeland are widely agreed upon (Lovich and Bainbridge 1999). Overgrazed desert lands typically contain a high percentage of weedy annual and perennial species, and areas around stock tanks are typically devoid of vegetation (Berry 1978). Some research indicates that even limited grazing can cause a significant change in vegetation and damage to soil crusts (Lovich and Bainbridge 1999).

Impacts

Livestock grazing has contributed to the destruction of burrows, shrubs, and other retreat sites; mortality of individuals and eggs; competition for forage; soil compaction; and the significant change of the character of native desert scrub vegetation communities. Some studies have linked grazing to desert tortoise population declines (Berry 1978; Coombs 1979). The reduction of food supply and other grazing impacts may lead to slower growth rates (and delayed maturity), reduced clutch numbers, change in age class structure, and imbalanced sex ratios (Berry 1978). The USFWS (1994a, 1994c) describes additional effects that grazing and associated infrastructure may have on the desert tortoise and their habitat, including impacts to cryptogamic crusts and desert soils; reduced water infiltration; erosion; inducing of Upper Respiratory Tract Disease; changes to the natural fire regime; degradation of water sources; and fragmentation of habitat due to fencing and cattleguards, construction of new roads, and decreases in natural cover.

In addition to the effects from grazing livestock, additional impacts result from existing infrastructure on rangeland (e.g., roads, fences) as well as construction and maintenance of new range developments. During range improvement construction, maintenance, and inspection, some desert tortoise mortality or injury could result through collisions with vehicles or other equipment (USFWS 2007). Access roads to new or existing range developments could lead to desert tortoise mortality through illegal collection, vandalism, crushing by vehicles, and shooting (USFWS 2007). Large-scale range improvement projects could lead to soil disturbances and a decrease in vegetative cover, providing favorable conditions for a variety of cumulative threats.

Because grazing has been continuous since the mid 1800s and little is known about desert tortoise population densities prior to the commencement of grazing activities, it is difficult to assess the true impacts of grazing to desert tortoise populations and numbers. Furthermore, desert tortoise numbers have been in decline over the last 50 years, while management of grazing activity has increased and grazing has been reduced during this time. However, grazing is associated with numerous factors that modify and degrade the natural environmental conditions of desert tortoise habitat, directly and indirectly affecting desert tortoise individuals and populations as described above. In its 2002 report on the desert tortoise (GAO-03-23) the United States General Accounting Office raised concerns that there was a lack of information regarding the potential for desert tortoise recovery as a result of increased control on livestock grazing, and the question remains: will cessation of grazing activity in desert tortoise habitat result in increases to desert tortoise numbers and population densities? Specifically will it result in increases in desert tortoise numbers as outlined in the 1994 Desert Tortoise Recovery Plan?

Mojave Desert vegetation probably did not co-evolve with large, grazing, herbivorous mammals. Although pronghorn antelope were natively present in the western part of the Mojave Desert and bighorn sheep occur naturally at higher elevations in the Mojave Desert, desert plant communities are not well adapted to the behavior of large herds of grazers, particularly domestic grazers such as sheep and cattle. Anecdotal evidence and some early records (Woodbury and Hardy 1940, 1948) indicate very high numbers of desert tortoise in the middle of the 20th century despite decades of heavy grazing in the late 1800s and early 1900s (Borman and Johnson 1990; Oldemeyer 1994). There is little disagreement that desert tortoise numbers have declined significantly over the past 50 years. However, regulations on grazing that originated with the Taylor Grazing Act in 1934 have been further strengthened over the last 50 years with the National Environmental Policy Act (1969), the Federal Land Policy and Management Act (1976), and the Public Rangeland Improvements Act (1978). Despite increased grazing management and reductions in grazing activity over the past 50 years, desert tortoise numbers have declined precipitously during this time. If livestock grazing is the predominant threat to the desert tortoise, we would expect that desert tortoise populations would be showing signs of recovery as grazing regulation were tightened and grazing reduced over the past 50 years. However, the impacts of grazing to desert habitat are complicated and intertwined with several other factors.

Livestock grazing results in impacts to desert soils that may require decades or centuries for recovery following cessation of grazing activity. Grazing activity compacts soil and destroys cryptogamic or cryptobiotic soil crust (Anderson et al. 1982a). A diverse cryptobiotic community forms in arid soils and includes cyanobacteria, lichens, and mosses, which can represent over 70 percent of the living ground cover in desert areas, and plays an important ecological role. Cryptobiotic crusts increase the stability of otherwise easily eroded soils, increase water infiltration in regions that receive little precipitation, and increase fertility in soils often limited in essential nutrients such as nitrogen and carbon (Kleiner and Harper 1977; Anderson et al. 1982a, 1982b; Harper and Marble 1988; Metting 1991; Johansen 1993; Belnap and Gardner 1993; Belnap 1993, 1994; and Williams et al. 1995). The cyanobacteria that occur within the soil are commonly filamentous in nature. When these organisms – which persist in sheaths – are moistened, the filaments become active and move through the soils, leaving a trail of the sticky, mucilaginous sheath material behind. This sheath material sticks to surfaces of rocks and soil particles, forming a web of fibers in the soil. This process results in soils that exhibit resistance to wind and water erosion to a depth of up to 15 cm in an otherwise unstable and highly erosion-prone surface (Belnap 1994). The cyanobacteria and cyanolichen within these soil crusts are important contributors of fixed nitrogen (Mayland and McIntosh 1966; Rychert and Skujins 1974), and are likely the dominant source of fixed nitrogen in desert soils. Although some disturbance is normal and helps the soil to capture moisture, excessive disturbance by a variety of anthropogenic threats, including livestock grazing and off-highway vehicle use, compacts soils and destroys cryptogamic soil crusts (Anderson et al. 1982b). Because the organisms in the soil crusts become metabolically active only when wet, the re-establishment of cryptogamic communities in desert soils is slow. Furthermore, while cyanobacteria are mobile, and can move through disturbed sediments to reach the necessary light levels for photosynthesis, lichens and mosses are incapable of such movement, and often die as a result. Therefore, mosses and lichens exhibit extremely slow colonization and growth rates on newly disturbed surfaces. Assuming adjoining soils are stable and rainfall is average, recovery rates for lichen cover in southern Utah have been most recently estimated at a minimum of 45 years, while recovery of moss cover was estimated at 250 years (Belnap 1993). Webb (1983) postulated that certain soils may require 5,000 to 10,000 years to form. Because of the slow development of cryptogamic communities on disturbed soil surfaces, the soils may be vulnerable to both wind and water erosion for at least 20 years following disturbance (Belnap and Gillette 1997). Loss of soil would result in loss of site fertility through loss of organic matter, fine soil particles, nutrients, and cryptogamic communities in the soils (Harper and Marble 1988; Schimel et al. 1985). Moving sediments further destabilize nearby areas by burying crusts, leading to their death, or by providing material for "sandblasting" nearby surfaces, thus increasing wind erosion rates (Belnap 1995; Neumann et al. 1996).

Overgrazing in the Mojave Desert by livestock has also provided many opportunities for non-native plants to establish footholds in the region. Grazing, by essentially clearing an area of native vegetation, allows non-native plant species to establish populations with little or no competition from native species. This is particularly true for non-native grasses, and the increase in non-native grasses in the Mojave Desert has resulted in increases in the extent and number of wildfire occurrences in the region. Because the Mojave Desert is poorly adapted for fire regimes (D'Antonio and Vitousek 1992), recovery following fires is slow. Studies on succession following disturbance indicate that recovery of long lived species, such as creosote (*Larrea tridentate*) can be very slow, taking hundreds of years for habitats to fully recover (Brown and Minnich 1986; Vasek 1980, 1983). Recovery of soil and vegetation in Ghost-towns of the Mojave was found to be incomplete after close to 100 years, and Bowers et al. (1997) showed that succession of desert plants on debris flows in Arizona required millennia to reach full maturity. The combination of destruction of cryptogamic soils, the clearing of native vegetation over large areas, the invasion of non-native plant species (particularly grasses), and the increased rate of wildfires resulting from the presence of invasive plants result in major modifications to the desert tortoise habitat that may require extended periods for recovery. Reducing grazing activity or even completely halting grazing on desert tortoise habitat may not have an immediate effect on desert tortoise recovery if the species requires a return to natural habitat conditions, as desert environments are characteristically slow to recover from disturbance.

Mortality

Mortality or injury to tortoises may occur if livestock step on individual desert tortoises or their eggs; injured and dead tortoises have occasionally been found with damaged shells from trampling (BLM 1991; Berry 1978). The likelihood of trampling tortoises and burrows increases in areas of livestock concentration, such as around watering holes. Crushing of desert tortoise burrows, pallets, and shrubs used for shelter has been noted in several studies of the effects of cattle and sheep grazing (Avery 1993; Berry 1978; Boarman 2002a; Nicholson and Humphreys 1981; USFWS 1994a; Webb and Stielstra 1979). Collapsed burrows may be fatal when tortoises are entombed within them or when a tortoise cannot return to a shelter-site during extreme heat or cold (Berry 1978). Avery (1993) noted that cattle trampled and destroyed 50% of tortoise burrows, as well as shrubs associated with active burrows, at a study site in the Ivanpah Valley. Crushed tortoise and rodent burrows were also observed during a study into the effects of sheep grazing within the Cantil Common Allotment of the western Mojave Desert (Webb and Stielstra 1979). Nicholson and Humphreys (1981) reported that 10% of tortoise burrows were damaged and 4% were destroyed on a 1-square-mile study site grazed by sheep on BLM lands near Barstow. Damage occurred primarily to burrows that were located in relatively more open areas (Nicholson and Humphreys 1981). Berry (1978) points out that livestock are more likely to trample shallow burrows in open areas and are unlikely to affect deeper burrows in the banks of washes.

Habitat Degradation

Livestock grazing contributes substantially to soil compaction. Compacted soils disrupt soil crust development, reduce water infiltration, and increase surface run-off and erosion. The most significant areas of soil compaction are associated with areas where livestock congregate, such as watering troughs and bedding areas (Berry 1978; Brooks et al. 2006; Matchett et al. 2003; Webb and Stielstra 1979). Artificial watering sites associated with grazing operations create disturbance gradients referred to as "piospheres," where soil compaction, destruction of cryptogamic crusts, and changes in the characteristics of soil nutrients was observed (Brooks et al. 2006). Measured soil disturbance on BLM lands near Barstow used for sheep grazing was found to average 80% at bedding sites and 74% at heavily used areas (Nicholson and Humphreys 1981). Tramping by wild horses and burros has also been attributed to soil compaction and changes in the shrubland community in proximity to water courses (Lei 2003).

Soil compaction from livestock trampling contributes to reduced water infiltration, increased rates of erosion (Castellano and Valone 2007; Daniel et al. 2002; Webb and Stielstra 1979), and conditions that favor non-native weed species (Belsky and Gelbard 2000). Castellano and Valone (2007) compared soil compaction, water infiltration rates, and vegetation in three livestock exclosures that differed in time (54, 25, and 10 years) since livestock removal and perennial grass recovery in San Simon Valley, Arizona. Long-term removal of livestock resulted in increased water infiltration rate and reduced soil compaction when the three sites were compared. The researchers concluded that the time it takes for soils to recover from compaction after livestock removal explains the long recovery rate of vegetation in arid grasslands (Castellano and Valone 2007).

Compacted soils due to trampling and vehicles may affect the local native plant seed bank. In a study area near Fort Irwin, the density of viable seeds of native annuals were one-third the density compared with undisturbed areas, and perennials also showed a slight decrease (DeFalco et al. in press). The study demonstrated that soil seed densities in the Mojave Desert are influenced by both disturbed soils and by the direct losses of native seed-bearing plants.

In addition to soil compaction, livestock can increase nitrogen in soils (via urine and dung), which increases invasion of some weeds such as cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum)* by stimulating germination of their seeds and enhancing their growth over that of native species (Belsky and Gelbard 2000). These areas of high nitrogen content are found in areas where livestock congregate such as near streams, fences, water tanks, and salt licks.

One of the most important effects that livestock grazing produces is changes to desert scrub vegetation communities. Changes in vegetation caused by grazing result from reducing or removing annual forage species or by changing species composition and diversity (USFWS 2007). Native perennial bunchgrasses and other highly palatable native annual species have become less abundant in many areas (Berry and Nicholson 1984; McClaran and Anable 1992). Overgrazing has a major role in the change from perennial grasses to shrubs and bare soils in arid and semi-arid environments; this desertification is difficult to reverse (Castellano and Valone 2007). Kerley and Whitford's (2000) study of the effects of grazing and desertification on desert grasslands in the Chihuahuan Desert found that grazing reduced the cover of perennial grasses, particularly the dominant black grama (*Bouteloua eriopoda)*, but the cover of forbs and shrubs was not affected. Their study was consistent with historical shifts from long-lived perennial grass (black grama) to short-lived grasses (Sporobolus and Aristida) and trends from short-lived perennial grasses to shrub domination in grazed pastures.

Trampling of perennial shrubs by grazing livestock likely cause important changes in the character of vegetation communities. Sheep trampling has been attributed to destruction of creosote shrub coppice mounds, an important source of shade for tortoises, as well as forming structurally stable locations for burrow entrances. Although creosote itself is not consumed by grazing livestock, it and other perennial shrubs are trampled during sheep bedding and movements (Webb and Stielstra 1979). Webb and Stielstra (1979) found that heavy sheep grazing decreased the cover of individual perennial shrubs 16% to 29%. Destruction of perennial shrubs by grazing livestock degrades desert tortoise habitat by reducing the availability of retreat sites that provide important shade resources. A reduction in perennial shrubs could also make desert tortoises more susceptible to predation.

Piospheres are particularly damaging to desert vegetation communities because they contribute to substantial changes in several habitat parameters: native plant biomass, seedbanks and cover are reduced, defoliation is increased, species composition may be highly modified, and reproductive output is impacted (Brooks et al. 2006). The total annual plant species richness, native annual plant richness, perennial species richness, and perennial plant cover all decreased near watering sites (Brooks et al. 2006). In addition to the direct effects of livestock grazing to vegetation communities, grazing

infrastructure (fencing, cattleguards, roads, and watering/bedding sites) results in fragmenting habitat, degradation of vegetation communities through the reduction in diversity and cover of annual forage and perennial scrub species, and can contribute to habitat fragmentation.

Natural recovery rates of desert vegetation depend on the nature and severity of the impact but are generally very slow. The rate of natural recovery of habitats exposed to grazing depends on the intensity of past grazing and local conditions (e.g., climate, soils) (Lovich and Bainbridge 1999). Where livestock are excluded or grazing is light after years of overgrazing, decades or even centuries may be required for vegetation to recover (Berry 1978; Castellano and Valone 2007; Lovich and Bainbridge 1999). A long-term study in the Sonoran Desert showed an "exceptionally slow" recovery of perennial vegetation in an area disturbed by prolonged heavy grazing and other human impacts (Guo 2004). Although species richness increased over time, the study site showed little recovery of desert perennial vegetation after 50 years of protection from grazing. In their review of desert vegetation recovery studies, Webb et al. (1987) found that revegetation requires longer than 66 years and depends on the severity of disturbance. In their own study of Mojave Desert shrub communities, Webb et al. (1987) found that re-establishment of total shrub cover required between 46 and 64 years, depending on the type and age of disturbance. Although the recovery of the natural habitat may take extended periods, Brooks et al. (2003) found vegetation changes (i.e., increased biomass of annuals) benefited tortoise after only 10 to 15 years of fenced habitat protection.

Cattle and sheep grazing may remove important desert tortoise forage, resulting in competition between grazing livestock and tortoises (Berry 1978; Karl 1981; Coombs 1979; USFWS 2007). Desert tortoises forage primarily on green annual forbs (Avery 1996) and to a lesser extent on perennial and annual grasses (Coombs 1979), all of which are also consumed by grazing livestock. During the spring, when tortoises consume most of their annual resources, livestock eat many of the same annuals and grasses consumed by tortoises (Berry 1978). Webb and Stielstra (1979) found that heavy sheep grazing caused a 60% reduction in above-ground biomass of annual vegetation. Such significant reductions in forage availability likely lead to competition between desert tortoises and livestock.

The degree of dietary overlap between desert tortoises and livestock is difficult to determine because the diets of these species vary with season, rainfall, and vegetative type. However, a number of studies indicate that a significant degree of overlap occurs. The dietary overlap between desert tortoises and grazing livestock has been documented to be as high as 60% on the Beaver Dam Slope in Arizona and Utah (Hohman and Ohmart 1980; Coombs 1979). Coombs (1979) found a 37% overlap between diets of desert tortoise and cattle, where both species exhibited a preference for perennial grasses. Avery (1998) found a 38% overlap in diets of cattle and tortoises in early spring when the availability of fresh annual vegetation was greatest; dietary overlap declined by 16% by late spring after annuals had dried and tortoises shifted to eating cacti, a food item not consumed by cattle. Medica et al. (1982) determined that desert tortoises and cattle principally competed for perennial grasses in Ivanpah Valley, and that tortoises reduce competition with cattle by foraging on cacti. While shifting to a diet that relies more heavily on cacti may reduce the degree of dietary overlap with cattle, it seems unlikely that tortoises are shifting to cacti as a means of reducing competition. Competition among species for resources and the modification of such competitive relationships are evolutionary processes requiring sufficient time for evolutionary change. Cattle and desert tortoise have been in competition for a relatively short time, too short for evolutionary adaptations in feeding characteristics to have evolved. It is more likely that tortoises are shifting to cacti as part of their normal annual feeding pattern where cacti become more important as perennial grasses or annual plants become less available as a result of annual climate patterns, but which may also become less available as a result of grazing.

Dietary overlap may cause tortoises to alter their foraging behavior or shift their diet to overcome limitations posed by competing with livestock. Avery (1998) reported a shift in diet by desert tortoises

due to foraging competition with cattle. Avery (1999) showed that tortoises in grazed areas spent more time foraging than those in protected areas, further suggesting that cattle grazing altered the foraging behavior of tortoises. Risks associated with shifts in diet and other modifications in foraging behavior by tortoises include decreased nutrition, allocation of more energy resources to finding food, and increased vulnerability to heat and predation during longer foraging forays.

Cumulative and Interactive Effects with other Threats

Invasive Plants

Grazing provides a vector for dispersal of invasive seeds, removes native forage, alters the structure of plant communities, and causes soil disturbances favorable to invasive establishment (Berry 1998; Boarman 2002a; Brooks and Pyke 2002; Jennings 1997b). In addition, artificial water catchments for domestic livestock and wildlife have been shown to harbor more invasive plants near the water source compared with native plants (Brooks et al. 2006).

Belsky and Gelbard (2000) summarize how livestock contribute to invasive plant invasions by: 1) transporting weed seeds into uninfested sites on their coats, feet, and in their guts; 2) preferentially grazing native plant species over weed species; 3) creating patches of bare, disturbed soils that act as weed seedbeds; 4) destroying microbiotic crusts that stabilize soils and inhibit weed seed germination; 5) creating patches of nitrogen-rich soils that favor weed species; 6) reducing concentrations of soil mycorrhizae required by many native species; and 7) accelerating soil erosion that buries weed seeds and facilitates their germination. Their review of research into the relationship between grazing and invasive plants concluded that livestock significantly increase invasions by non-native weeds in arid environments of the western U.S. and control of invasive plants requires changes in grazing management.

The disturbance of soils and vegetation communities due to grazing activities contributes to the spread of invasive plants (Coombs 1979; Jennings 1997b). A number of non-native annual plants, including Mediterranean grass (*Schismus arabicus*), red-stemmed filaree (*Erodium cicutarium*), and red brome (*Bromus rubens madritensis*) have increased in desert communities through livestock grazing (Berry and Nicholson 1984; Brooks et al. 2006; McClaran and Anable 1992). Trampling of soils and vegetation in the vicinity of piospheres resulted in an increase in the abundance of non-native species, a pattern that generally increased with proximity to these artificial watering sites (Brooks et al. 2006). Thus, watering sites facilitate the spread of invasive plant populations, providing a “launch pad” into the vicinity. Invasives noted in grazed areas of the Mojave Desert included herb Sophia (*Descurainia sophia*), red-stemmed filaree, brome grasses, and Mediterranean grass. (Brooks et al. 2006). Lehmann lovegrass (*Eragrostis lehmanniana*) was associated with grazing in Arizona, but density was not associated with piospheres (McClaran and Anabel 1992).

The spread of invasive annual grasses may contribute to nutritional constraints for desert tortoises. Coombs (1979) reported that following 100 years of livestock grazing on the Beaver Dam Slope, Utah, perennial grass populations declined and invasive annual grass populations increased. Tortoises there primarily consumed two non-native annual grasses, which the author attributed to decreased availability of their preferred food, perennial grasses (Coombs 1979). The author suggested that this dietary shift could affect the abilities of desert tortoises to obtain their annual water and nutrient requirements, as perennial grasses typically provide water and nutrients from spring into the fall months, whereas annual grasses senesce and dry by late spring (Coombs 1979).

Fire

The spread of non-native annual grasses and other invasive plant species as a direct result of grazing contributes to increased fire hazard/susceptibility (discussed in detail in the Fire section). Because Mojave Desert environments include an abundance of long-lived and slow growing plant species, and because these environments are poorly adapted to fire regimes, post fire recovery is slow (Brown and Minnich 1986). Increases in fire occurrence, extent, and intensity as a result of the invasion of on-native grasses have significant impacts to the desert environment, further reducing quality desert tortoise habitat, and requiring extended periods for habitat recovery. Research in the Sonoran Desert showed that native species, particularly creosote (*Larrea tridentate*), that are poorly adapted to fire regimes were replaced by open stands of native ephemerals and European exotics following even low intensity fires. Recovery to a natural condition after fire can be a slow process, and grazing could affect post-fire community development (Abella 2009) further slowing the time of recovery.

Other Cumulative and Interactive Threats

Livestock grazing practices include providing water sources for the livestock. These anthropogenic water sources likely attract subsidized predators.

<u>Distribution within Conservation Areas</u>

Grazing was previously widely distributed over both of the Conservation Areas, but recent management decisions have included closure of all closure of grazing allotments on the Nevada portion of the Gold Butte-Pakoon Conservation Area using funds generated from the Clark County Multiple Species Habitat Conservation Plan (MSHCP), and closure of all grazing allotments within the Superior-Cronese Conservation Area as a mitigation measure for the Fort Irwin Land Expansion Project in 2006 (see Figures D-16 through D-17 in Appendix D). Despite closure of the grazing allotments on the Nevada side of the Gold Butte-Pakoon Conservation Area, trespass continues (Figure D-16 in Appendix D).

Using remote sensing techniques, we attributed fairly expansive areas of vegetation and soil change to grazing (confirmed and suspected areas) within the Gold Butte-Pakoon Conservation Area (Figure E-4 in Appendix E). Likewise, we detected areas of change due to grazing within the Superior-Cronese Conservation Area (Figure E-19 in Appendix E).

Agricultural Practices

The 1994 Desert Tortoise Recovery Plan (USFWS 1994) stated that the most significant way agriculture affects desert tortoises is through loss of habitat. Once land has been converted to agricultural fields, the habitat becomes unsuitable to tortoises for foraging or burrowing (USFWS 2008). Agricultural practices may also contribute to the degradation of adjacent desert habitats, and fragmentation of landscapes that could curtail desert tortoise dispersal. Additionally, agricultural activities may draw down the water table, further degrading habitat. Agricultural activities such as discing, plowing, mowing, and baling could potentially destroy burrows and kill desert tortoises (Stubbs 1989 in Boarman 2002). Agricultural fields provide subsidies to common ravens and other predators of desert tortoises (Knight et al. 1993; 1999); thus local agricultural activities may have affects on tortoise populations on undeveloped lands within several kilometers of agricultural fields.

Cumulative and Interactive Effects with other Threats

Invasive Plants

Soil disturbances, fertilizers, and anthropogenic water sources associated with agricultural practices likely contribute to the spread of invasive plants. Non-native and invasive species often out-compete native plants in the reestablishment of vegetative cover on fallow or abandoned agricultural fields, which may reduce the abundance and diversity of native food and shelter species for desert tortoises (Hobbs 1989; USFWS 1994).

Subsidized Predators

Agricultural fields may provide food and water subsidies for ravens and thus create additional pressure on surrounding desert tortoise populations (Boarman 2002). Agricultural fields are likely important sources of food and water for ravens during times of the year when those resources are generally in low abundance elsewhere, thus resulting in more ravens surviving the summers and winters (Boarman 1993; 2002). Boarman et al. (1995) observed that 90% of telemetered raven relocations were within 4.46 km of anthropogenic resource subsidies (landfills) in the west Mojave Desert – a pattern that may be inferred for agricultural fields that provide food subsidies for ravens.

Other Cumulative and Interactive Threats

Irrigation of agricultural fields provides anthropogenic water sources for subsidized predators. Agricultural practices such as plowing may create dust or leave barren areas in fields that combine with strong winds to create dust storms or fugitive dust, affecting air quality. Fugitive dust coats plants, which in turn may reduce photosynthesis and water-use efficiency in plants (Sharifi et al. 1997 in Boarman 2002), and can cause decreases in productivity of desert tortoise forage plants. Agricultural practices introduce toxic chemicals such as pesticides into adjacent desert habitats.

Distribution within Conservation Areas

Agriculture is not practiced within the Gold Butte-Pakoon Conservation Area, but there are agricultural fields along the Virgin River riparian corridor adjacent to the Conservation Area (Figure D-18 in Appendix D). These fields would likely only indirectly impact desert tortoise populations in the Conservation Area by subsidizing common ravens and other predators of desert tortoises.

There are numerous private land in-holdings in the western and southern portions of the Superior-Cronese Conservation Area in the vicinity of Harvard and Hinkley, as well as adjacent lands outside of the Conservation Area, that support agricultural production (Figure D-19 in Appendix D). Agricultural fields occur over many acres on land in-holdings within the Conservation Area; these are areas of lost habitat on lands that should (in theory) be considered for conservation acquisition, as they are situated within designated Critical Habitat and are surrounded by federal lands. The proximity of these agricultural fields to desert tortoise habitat within the Conservation Area likely provides a considerable threat to tortoise populations, including mortality to tortoises that may wander onto agricultural fields, as well as indirect effects such as subsidizing desert tortoise predators, and providing a source for invasive plant populations and fugitive dust.

Mineral Extraction

Impacts

Although there is limited information on the specific impacts of mining activities on desert tortoises, impacts are likely similar to those associated with other development activities, including mortality of desert tortoises, habitat loss, and degradation of adjacent habitat. Mortality may stem from off-road exploratory travel and extraction activities. Desert tortoises can also become trapped within mine shafts an within steep-sided excavations left as a result of mining activity, and trapped or killed by collapsed burrows as a result of blasting (USFWS 1992a). Degradation of adjacent habitat occurs through the introduction of toxins and fugitive dust, and soil disturbance and erosion.

Cumulative and Interactive Effects with other Threats

Toxins and Pollutants

Pollutant deposition from waste rock and tailings can leach into soil and aquatic resources, and toxic particulate metals may become suspended from active mining (Salomons 1994). Chaffee and Berry (2006) reported anomalously high concentrations of arsenic in soil and plant samples collected in or near known arsenic-rich ore mines. These chemicals were detected in 13 plant species known to be consumed by tortoises, including five species favored by tortoises. Arsenic was the only toxin found range-wide for tortoises, and high concentrations of mercury were found in the Western Mojave Desert. Abnormally high soil concentrations of several elements, including arsenic, gold, cadmium, mercury, antimony, or tungsten were found up to 15 km from active mining sites, and unusually high plant concentrations of arsenic, antimony, or tungsten were found at least 6 km away from old mines. Detecting toxicants with total chemical analysis does not necessarily indicate a threat to desert tortoises because bioavailable concentrations may not have any toxic effects. However, sick tortoises with elevated levels in the liver of arsenic and mercury were found in previous studies in areas of the western Mojave Desert corresponding to those where these anomalies occurred (Jacobson et al. 1991; Seltzer and Berry 2005).

Other Cumulative and Interactive Threats

Though not well researched, mineral extraction activities likely produce a variety of cumulative effects, including deposition of garbage and litter by mining crews and attraction of subsidized predators. Leachate ponds are anthropogenic water sources that likely attract subsidized predators. Fugitive dust from mining operations contribute to air quality conditions that interfere with gas exchange on desert shrubs (Sharifi et al. 1997). Mining may increase the use of public lands by OHV users and other recreationists, and create disturbance zones (both at the mine site and along access roads) where invasive plant species can establish (USFWS 2008a). Finally, mines are accessed by roads.

Distribution within Conservation Areas

Mining activity in the Gold Butte-Pakoon Conservation Area is most concentrated in the southwest portion of the Conservation Area (Table 9; Figure D-20 in Appendix D). A number of additional mining sites exist along the northern border and along the Nevada-Arizona border, just outside the boundaries of the Conservation Area. The Nevada portion of the Conservation Area has been segregated from mineral entry since 6 November 2002 following passage of Public Law 107-282, the Clark County Conservation of Public Land and Natural Resources Act of 2002. The segregation expires in November 2009. The BLM has applied for a 20-year withdrawal from mineral entry and patent for all ACECs in the Southern Nevada District (over 950,000 acres). This proposed action is pending Secretary of Interior approval. Until this proposed action is approved, mining claims that are not renewed are closed. One mine in Cedar Basin (south of the Gold Butte Townsite) was closed through this process.

The density of mining activity is considerable in the central portion of the Superior-Cronese Conservation Area in the vicinity of the Mud Hills and Calico Mountains; additional clusters of mines are present in the eastern and southern parts of the Conservation Area (Table 9; Figure D-21 in Appendix D). Many of the mines are associated with access roads that terminate at the mine. We detected several incipient or expanded mines during the period of study (1990-2008) using remote sensing techniques (Figure E-20 in Appendix E).

Table 9. Summary of Mineral Extraction Sites in each Conservation Area

Gold Butte-Pakoon	Number of Mines*
Past Producer Mines	15
Producer Mines	2
Explored Prospect Mines	48
Raw Prospect Mines	8
Unknown Mines	3
Total Mines	76
Superior-Cronese	**Number of Mines***
Past Producer Mines	94
Producer Mines	11
Explored Prospect Mines	268
Development Initiated Mines	1
Raw Prospect Mines	61
Unknown Mines	6
Total Mines	441

*Source: UGS, BLM and UGUS mine and mineral claim locations

Military Activities

Impacts

Military activities result in tortoise mortality, and destruction, degradation, and fragmentation of tortoise habitat. Large areas of infrastructure are often associated with military activities, including bases, air strips, roads, and firing ranges. The presence of military facilities also gives rise to the development of local urban, industrial, and commercial facilities, which contribute to the loss of habitat. Field maneuvers, including tank traffic, air to ground bombing, and static testing of explosives, may contribute to tortoise mortality and habitat degradation. Severely impacted areas likely contribute to habitat fragmentation.

Cumulative and Interactive Effects with other Threats

Military bases support urbanized areas that increase the potential for attraction of subsidized predators and an increase in domestic predators, deposition of litter and trash (including household trash, unexploded ordinance, shell casings, and ration cans), and OHV use. Developments associated with military bases, facilities, and training areas include roads, landfills, and anthropogenic water sources. Tortoises in the vicinity of military bases exhibit increased disease incidence (Berry et al. 2006), and expansion of training areas results in the translocation of tortoise populations. Military maneuvers and use

of explosives create fugitive dust, introduce toxins and pollutants into desert environments, increase the potential for wildfire in desert environments, and lead to the spread of invasive plants.

Distribution within Conservation Areas

Military activities and sites within and adjacent to the Superior-Cronese Conservation Area may attract ravens, impact habitat, or cause direct mortality of desert tortoise. Three military-related features within the Conservation Area include the Cuddeback Lake Gunnery Range, the Superior Valley Gunnery Range, and the Manix Trail. The Cuddeback Lake Gunnery Range is located in the northwest corner of the Conservation Area on the China Lake Naval Weapons Center (Figure 21) and was originally established in the 1940s as a World War II artillery range by the US Army. In the 1950s and 1960s, the range was used as both a temporary landing site for U. S. Air Force training and as a practice bombing range. Though the range has been abandoned by the U. S. Air Force, it may still contain unexploded ordinance and toxic chemicals, as it is included in the California Department of Toxic Substances Control cleanup list (DTSC 2007). The Superior Valley Gunnery Range straddles the northern border of the Conservation Area boundary near Superior Lake, and is part of the China Lake Naval Weapons Station. Portions of the Superior Valley Gunnery Range, including a simulated airfield and missile batteries, are within the Conservation Area, though the majority of this feature is outside of the conservation area (Figure 24). Similar to the Cuddeback Lake Gunnery Range, this site may contain unexploded ordinance and hazardous chemicals and as such, is listed on the California Department of Toxic Substances Control cleanup list (DTSC 2007).The Manix Trail consists of an improved dirt roads that crosses the Conservation Area and connects the Manix railhead on the Union Pacific Railroad, adjacent to I-15 in the south, to Fort Irwin in the north. The road is wide and supports the transport of heavy military equipment such as tanks and personnel into and out of Fort Irwin (McIntyre et. al. 2007). McIntyre et. al. (2007) noted that ravens are keenly aware of the bi-monthly movement of some 4000 troops along the Manix Trail, and are known to follow soldiers and steal food rations. The attraction of ravens likely increases the potential for predation on juvenile desert tortoises in the vicinity. The regular movement of vehicular traffic along the road may also increase the potential for road kill of desert tortoise. We detected change on Manix Trail during the period of study (1990-2008), which resulted from oiling of the road (Figure E-14 in Appendix E).

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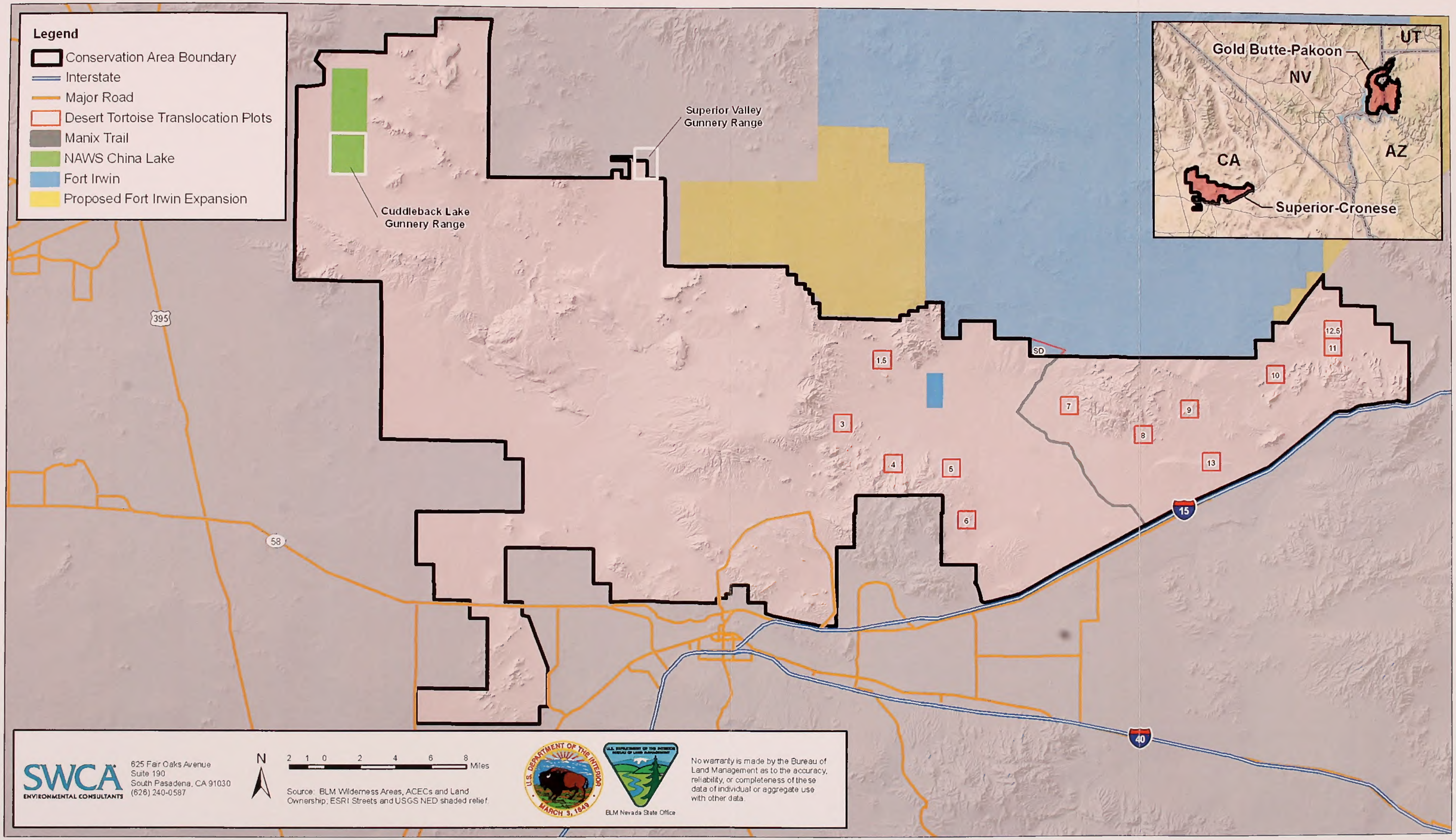

Figure 21. Locations of the Ft. Irwin expansion areas, translocation plots, and Manix Trail within and adjacent to the Superior-Cronese Conservation Area.

Litter and Illegal Dumping

Impacts

Tortoises may become entangled in trash such as string and rubber bands, and consume pieces of glass, foil, and balloons (Burge 1989; Walde et al. 2007), possibly leading to impaction and death. Deposition of trash into desert environments contributes to habitat degradation.

Cumulative and Interactive Effects with other Threats

Illegal dumping of household trash, construction debris, and hazardous waste is commonplace and ubiquitous in the desert, particularly near urbanized areas and along roads, including access roads to utilities, landfills, and mines. Trash dumps attract and subsidize ravens and coyotes. Illegal dumping sites have been documented in California deserts to contain hazardous wastes (Boarman 2002a), contributing to the introduction of toxins and pollutants into desert environments. Dump sites likely increases exposure of tortoises to toxic substances and potentially increased susceptibility to disease; however, this would likely remain a localized issue (USFWS 2008a). Trash may originate from OHV users, construction sites, and military training activities.

Distribution within Conservation Areas

Data regarding the distribution of illegal dump sites and other litter sources within the Conservation Areas is unavailable. During field research in the Gold Butte-Pakoon Conservation Area, we determined that trash dumps, scatters, and isolated pieces of trash were substantially more common on plots within the Urban Treatment Area adjacent to Mesquite (see Table 5). However, since trash dumps are most often associated with urban areas and roads, we predicted the distribution of areas affected by illegal dumping within each of the Conservation Areas (Figures E-5 and E-22 in Appendix E).

Toxin and Pollutant Deposition

Impacts

Elevated levels of metals have been found in desert tortoise tissue (Homer et al. 1998; Jacobson et al. 1991; Seltzer and Berry 2005), including the tissues of ill, dying, and recently dead desert tortoises (Jacobson et al. 1991); however, the source of these toxins was uncertain. Tortoises likely accumulate toxins in their tissues through the ingestion of plants containing heavy metals and other pollutants. Avery (1998) suggested that plants with fibrous root systems, whose roots are closer to the soil surface, may accumulate heavy metals through the deposition of airborne pollutant sources (e.g., vehicles). Chaffee et al. (1999) evaluated various plants and soils and found elevated concentrations of cadmium, potassium, and zinc in all plants.

Cumulative and Interactive Effects with other Threats

Toxins and pollutants originate from a variety of human developments, including urbanized areas, roads, railroads, utilities, landfills, and mines (as well as construction activities associated with these developments), and human activities, such as OHV use, agricultural activities, military activities, and illegal dumping. Airborne pollutants contribute to poor air quality and increased biomass of invasive plants. Additional sources of toxins and pollutants include many types of construction and mining activities, where spills, leaching, and toxic tailings from mineral extraction add toxins to the soil (Salomons 1994). Toxins and pollutants are included in a variety of threats that cause habitat degradation, which may lead to higher rates of disease incidence and disease-related mortality (USFWS 1994a,

2009b). Homer et al. (1998) suggested that environmental toxins may cause cutaneous dyskeratosis in tortoises, and experimental animals showed marked liver toxicity; however, a causative relationship has not been demonstrated between toxic chemicals and health effects on tortoises (Boarman 2002a). Nonetheless, because some data suggest a possible correlation, researchers have recommended that the effects of toxins and pollutants on desert tortoise health and disease be investigated further (Homer et al. 1998; Jacobson et al. 1991). Finally, some pollutants – particularly reduced nitrogen – that are introduced to the desert during agricultural activities may contribute to the abundance and spread of invasive annual plants, which in turn contribute to an increased probability of wildfires.

Distribution within Conservation Areas

Information regarding the distribution of illegal toxin dump sites and other toxin and pollutant sources within the Conservation Areas is unavailable. However, since toxins are most often associated with illegal dumping, mines, landfills, and military activity areas, we predicted the distribution of areas affected by illegal dumping within each of the Conservation Areas (Figures E-6 and E-23 in Appendix E).

Degradation of Air Quality

Air quality is compromised by the addition of fine particulate matter, which includes a mixture of small solid particles or compounds and suspended liquid droplets, into the air. Particulate matter includes acids (nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Particulate matter is regulated to protect public health, and standards have been adopted to control particles 10 microns in diameter and smaller (PM10) and 2.5 microns in diameter and smaller (PM2.5). Generally, about 10% to 15% of PM10 particulates include PM2.5 particulates. Particles in these size categories pose the greatest health problems for humans (and presumably all air-breathing animals), as they become lodged in lung tissue and may even enter the bloodstream. Particles larger than 10 microns are generally of less concern for affecting health, though these particles (primarily larger dust particles) are an irritant that affects eyes, nose, and throat tissue. Particulates that contribute to poorer air quality and the sources of these pollutants include the following:

- *Nitrates and sulfates* are fine particulate compounds formed from chemical reactions between sulfur dioxide or nitrogen dioxide with other substances present in the atmosphere. These compounds have a long atmospheric residence time, can be transported in the air over long distances, and are capable of penetrating deeply into the respiratory tract of humans and (presumably) animals. These compounds are produced primarily from fuel combustion by motorized vehicles.
- *Nitrogen oxides* (NO_X) are compounds composed of nitrogen and oxygen. The major source of NO_X production is the conversion of nitrogen-bearing fuels such as coal and oil to NO_X during combustion.
- *Hydrocarbons* are organic compounds composed of carbon and hydrogen molecules, the most dangerous being those derived from petroleum distillates. They form the principal constituents of petroleum and natural gas and serve as fuels, lubricants, and raw materials for production of plastics, fibers, rubbers, solvents, explosives, and industrial chemicals.
- *Ozone* (O3) is produced in the stratosphere naturally where it benefits the atmosphere, but is produced at the ground level by photochemical reactions with sunlight, oxygen, volatile organic compounds (VOC), and NO_X. Ozone produced in this manner contributes substantially to smog, and poses significant health threats. Combustion processes (including motor vehicle engines, power stations, or fires) are major sources of NO_X and VOCs that contribute to the formation of ozone.

- *Fugitive dust* is composed of small airborne dust particles. Significant sources of these particles include unpaved roads, agricultural cropland, active mines, and construction sites.

Impacts

Mortality

Ozone is a highly irritating gas that affects the airways and lungs of humans and mammals. In humans, ozone has been implicated in both temporary lung impairment and permanent lung function degradation. Most notably, the 10-year-long University of Southern California Children's Health Study found up to 50% permanent lung function impairment among those growing up in the most polluted parts of southern California. Ozone likely irritates the lungs of desert tortoises in similar ways, and may exacerbate the effects of URTD in tortoises. NO_X and hydrocarbons have carcinogenic or immune system weakening effects on humans (Lewtas 1983) in high enough concentrations and may weaken the immune response in desert tortoises. Fugitive dust irritates eyes, nose, and throat tissues, which could exacerbate URTD symptoms in desert tortoises.

Habitat Degradation

Nitrates are a primary concern in southern California deserts because they have been shown to increase soil nitrogen (Brooks 2003). Increased levels of soil nitrogen have been shown to increase invasive plant dominance and decrease the diversity of plant communities in desert systems (Allen et al. 2010). Deserts are especially susceptible to even small increases in soil nitrogen levels because the ratio of increased nitrogen to plant biomass is higher when compared with other ecosystem types (Brooks 2003). These community shifts increase fire hazards in addition to reducing native plant density (Smith et al. 2000). Dust affects desert vegetation by coating the surfaces of leaves, potentially interfering with gas exchange during photosynthesis, and suppressing plant growth (Walker and Everett 1987; Sharifi et al. 1997; Spellerberg and Morrison 1998).

Cumulative and Interactive Effects with other Threats

Disease

Fine particulate matter could contribute to an increase in the incidence and acuteness of URTD in desert tortoises. There is growing evidence that ozone and particulates have a synergistic effect to impair lung function. Chronic exposure to these particulates and compounds can worsen and prolong respiratory illnesses and weaken the immune system in humans, and may similarly affect desert tortoises with URTD.

Invasive Plants and Fire

Invasive annual plant productivity and wildfires carried by senesced invasive annuals increase in areas where nitrogen originating from pollutants produced as by-products of automobile emissions, especially around urban area and roads (oxidized N), and agricultural practices (reduced N) is deposited (Allen et al. 2010). Nitrogen deposition is particularly problematic in desert environments that are characterized by nutrient-poor soils. As invasive annual productivity increases near urban areas, roads, and agricultural fields, the biomass of senesced plants provides potential fuel for carrying fire, and areas that support approximately 9 kg N/ha of annual biomass are particularly susceptible to being burned (Allen et al. 2010).

Other Cumulative and Interactive Threats

Urban areas and vehicles traveling along major roads generate high levels of airborne pollutants, including particulates that contribute to ozone, aromatic hydrocarbons (Calvert et al. 1993), and NO_X (Lewis and Grant 1980). Railroads and OHV use contribute smaller amounts of pollutants. Fugitive dust is created during construction of utilities, landfills, roads, and other human developments, and is also created during mining, agricultural activities, and military activities. Unpaved access roads associated with utility corridors, landfills, and mines contribute to the addition of fugitive dust to the air, as does OHV use.

Distribution within Conservation Areas

Sulfates and nitrates are formed in the atmosphere by primary emissions from fuel combustion combining with water vapor and other compounds to create a fine particulate that settles downwind, sometimes hundreds of miles from the source. Anecdotal evidence appears to suggest that air quality has increasingly worsened in the Mojave Desert in the past two decades (Ray Bransfield, USFWS, personal communication, February 2009; Ken Nagy, University of California, Los Angeles, personal communication, March 2008).

Most ozone and PM10 is transported into desert areas from urban areas. For the Superior-Cronese Conservation Area, the primary source is the Los Angeles Basin; for the Gold Butte-Pakoon Conservation Area, the primary source is the Las Vegas Metro area. The Las Vegas airshed (hydrographic basin 212) was designated in serious non-attainment for PM_{10} in 1993, serious non-attainment for carbon monoxide in 1997, and serious non-attainment for ozone in 2004. The remainder of the airsheds in Clark County is in attainment, including Gold Butte.

Smog formation is strongly influenced by temperature—heat drives the reaction of hydrocarbons and NO_X to create ozone. Increases of even 1° C can increase the number of days with unhealthful air significantly. Thus, as smog emissions travel inland into the Mojave Desert from the Los Angeles Basin, ozone levels may increase substantially in response to the higher temperatures.

Fugitive dust is likely much more of an important issue in the Superior-Cronese Conservation Area, as unpaved roads, agricultural activities, and OHV use are much more prevalent.

We predicted the effects of nitrogen deposition near urbanized areas and major roads in the vicinity of each Conservation Area (Figures E-7 and E-24 in Appendix E).

Climate Change

Overall warming of the earth's climate system is substantiated by a large body of data that cover many scales in space and time. Generally, the earth's temperature has increased about 1° C since 1850, with some areas of the globe increasing as much as 4° C. This trend is a direct result of anthropogenic activities that have contributed to global atmospheric concentrations of the greenhouse gases carbon dioxide, methane, and nitrous oxide to levels that significantly exceed the natural range exhibited over the last 650,000 years. Prediction models project an additional 0.2 degrees Celsius average increase in temperature over the next two decades and 5° to 7° C over the next century under a range of emissions scenarios. Changes of this magnitude will significantly affect weather patterns worldwide, and are expected to increase extinction of sensitive species by approximately 30%. Within arid ecosystems, water availability is expected to decrease and temperature and drought conditions are expected to increase, with an increase in severe rainfall events despite lower mean rainfall regionally (Intergovernmental Panel on Climate Change [IPCC] 2007). Global climate change and its effects on rainfall and temperature patterns in desert systems is a long-term consideration for the recovery of the desert tortoise (USFWS 2008a). In a

landscape already affected and fragmented by anthropogenic threats, the addition of climate change will likely reduce the resiliency of ecosystems, thereby worsening the effects of existing threats (USFS 2009).

Impacts

Mortality

Based on general IPCC (2007) forecasts, both the low and high temperatures will increase in coming decades. Researchers have suggested that reptiles exhibiting temperature-dependent sex determination (TDSD) may be threatened by changes in temperature patterns that skew sex ratios within the populations (Booth 2006). Desert tortoises exhibit TDSD, whereby low incubation temperatures (26.0–30.6° C) produce males and higher temperatures (32.8–35.3° C) produce females (Spotila et al. 1994). The upper incubation temperature threshold for egg and hatchling viability is 35.3° C, and optimal hatching success occurs between incubation temperatures of 28.1° C to 32.8° C in dry sand (Spotila et al. 1994). Long-term increases in temperature from severe climate change can have consequences on the sex ratios and demographics of desert tortoise populations if temperatures permanently enter the incubation range that produces females. However, current hatchling prediction models for reptiles in general show that sex ratios are robust in mild-to-moderate warming, as reptile nests are typically shallow and subject to considerable fluctuations in incubation temperature (Booth 2006). Moreover, empirical evidence suggests that reptiles may compensate for climate variations with behavioral selection of nest sites (Doody et al. 2006).

Habitat Loss

Another potential response to increasing summer temperatures is movement to higher elevations by desert plants and animals. Long-term increases in temperature from severe climate change may cause range contractions, particularly in areas that do not support deep shelter sites at caliche caves. In addition, tortoises may respond to upslope movement of preferred forage vegetation by similarly occupying higher elevations. Under this scenario, tortoises may become restricted to isolated ranges of higher elevation hills and foothills, with little occupancy of lower elevation alluvial areas. This restricted distribution could produce genetic isolation of populations, with little gene flow occurring between isolated ranges.

Habitat Degradation

Because desert tortoises depend on the germination of annual vegetation stimulated by winter rainfall and drinking opportunities during summer monsoons for enhancing survival, changes to this rainfall regime poses a potentially significant threat. Models show that compared with current levels, the Great Basin–Colorado Plateau will see a drop in rainfall from 10% to 20% in the next 30 years (IPCC 2007). Summer monsoons are expected to increase in number and intensity, however, possibly enhancing desert tortoise survival by providing more drinking opportunities. However, the lower mean annual precipitation accumulations will likely affect winter rains. Winter droughts that result in reduced or no germination of native annual plants may become commonplace, reducing the availability of forage for desert tortoises.

Cumulative and Interactive Effects with other Threats

Invasive Plants

Changes in climate have the potential to affect vegetation by altering plant community structure and biomass, and increasing invasive species pervasiveness (Smith et al. 2000). Arid ecosystems are expected to be especially responsive to elevated atmospheric carbon dioxide and climate change (Melillo et al. 1993), and differences among species responses to increases in carbon dioxide can modify competitive

interactions and change plant community composition (Smith et al. 2000). In an experiment using free-air carbon dioxide enrichment technology in the Mojave Desert, Smith et al. (2000) found that native annuals and an invasive *Bromus* grass responded to elevated carbon dioxide with an increase in plant production, but *Bromus* developed a higher proportion of overall plant density compared with natives. This effect could enhance success of invasive plants, and potentially expose deserts to an expedited fire cycle that would further increase grass dominance (Smith et al. 2000).

Fire and Drought

Current climate change models for the Mojave Desert region indicate that wildfires and droughts will become more commonplace as global temperatures rise (IPCC 2007).

Other Cumulative and Interactive Threats

Greenhouse gasses that contribute to climate change originate primarily from homes and motorized vehicles within urban areas, as well as vehicles traveling along roads.

<u>Distribution within Conservation Areas</u>

Long-term effects of climate change will likely lead to range contraction to higher elevations or areas that support deep retreat sites (caliche caves). Within the Gold Butte-Pakoon Conservation Area, tortoise populations may contract from the Virgin Valley and other smaller low-lying valleys to foothills and bajadas that support caliche caves around Lime, Tramp, and Anderson Ridges in Part B of the Conservation Area, as well as foothills and bajadas around the Virgin Mountains in the northern portion of the Conservation Area. Within the Superior-Cronese Conservation Area, tortoise populations may contract from the valleys containing Harper Dry Lake and Coyote Dry Lake to foothills and bajadas supporting caliche caves around the Gravel Hills, Black Mountain, Calico Mountain, the Mud Hills, Paradise Range, and the Alvord Hills.

Collection and Poaching by Humans

Incidental and intentional take of desert tortoises by humans and human activities are a direct threat to tortoise survival, reproduction, and population viability (Boarman 2002a). Specific sources of take of tortoises include vandalism (Berry 1986b), collection for pets (Berry and Nicholson 1984), poaching (Berry et al. 1986; Schneider and Everson 1989), and accidental take through construction and maintenance of new developments (Boarman 2002a) such as mines, landfills (LaRue and Dougherty 1999), utility corridors, and roads (Boarman and Sazaki 2006; Boarman et al. 1997; Brooks and Lair 2005; von Seckendorff Hoff and Marlow 2002). Data on the impacts of these activities comes from a variety of sources, including anecdotal accounts and scientific studies, which are likely to underestimate numbers of deaths due to the cryptic nature of the animals and, in certain instances, the activities causing mortality (Berry and Nicholson 1984). For some human take impacts, no data is available (Berry and Nicholson 1984; Boarman 2002a). While direct mortality by vandalism and vehicles are simple to quantify when discovered, other forms of take, such as poaching and collection as pets, are more difficult to assess. Collectively, these sources of take likely contribute to remove significant numbers of individuals from desert tortoise populations (Berry 1986b; Berry and Nicholson 1984; Boarman 2002a; Grandmaison et al. 2009).

Impacts

Mortality

Vandalism is the illegal, deliberate harm or killing of desert tortoises, or damaging of their burrows. It includes deliberately shooting tortoises (Berry 1986b; Berry et al. 1986); turning over, driving over, burning, and decapitating tortoises (Berry and Nicholson 1984); and deliberate crushing or excavation of burrows. Vandalism has been identified in isolated events described by personal accounts from law enforcement, field researchers, and other individuals (Berry 1986b; Boarman 2002a), and in the case of gunshots, has been quantified in Berry (1986b) and Berry et al. (2006). Berry (1986b) found 14.3% of 635 carcasses taken from the Western Mojave, Eastern Mojave, and Colorado Deserts between 1972 and 1982 that showed evidence of bullet wounds. Western Mojave sites had the highest incidence of gunshots, where percentages of total carcasses ranged between 14.6% and 28.9%, compared with 0% to 3.1% in the Eastern Mojave sites, and 1.8% to 2.8% in the Colorado sites. These results suggest that the incidence of gunshots is higher near more urbanized areas, and in areas with greater vehicular access and more human visitors (Berry 1986b). Approximately 17% of the carcasses collected in the Fremont Peak PSP showed evidence of gunshot deaths (Berry 1986b). Berry et al. (2006) found signs of poaching, gunshot, or vandalism near the Superior-Cronese Conservation Area that accounted for 1.2% of total tortoise mortality on the Alvord Slope in the Southern Expansion Area of Fort Irwin, and 8.5% on the Goldstone plot in the Western Expansion Area.

Poaching is the taking of tortoises by humans for use as food or medicinal uses (Berry et al. 1996), whereas collection is the taking of tortoises as pets (Berry and Nicholson 1984). Cases of poaching are generally indistinguishable from collection because the method of acquisition is similar in the two activities. Poaching has been related to cultural activities (Berry et al. 1996) and appears to be rarer than vandalism and collection. Occurrences are mentioned in agency reports (USFWS 1994a, 2008b), reported in desert tortoise conservation group newsletters (see http://www.tortoise-tracks.org/newsletter/ttsummer2008.pdf and http://www.tortoise-tracks.org/newsletter/ttfall96.html), and reported by various witnesses in the field (Boarman 2002a). Berry et al. (1996) used law enforcement records, visual observations of suspected poachers, and signs of excavated tortoise burrows to determine the extent of collection within the Western Mojave Desert. They found signs of humans having excavated 7.7% of the burrows on PSPs in the study area (Berry et al. 1996). They deduced that poaching or collection may account for severe population declines in areas characterized by a lack of carcasses to account for the decline, and inferred that an influx of Cambodian nationals into the area were at least partially responsible for poaching that led to declines in local tortoise populations. As previously mentioned in the Roads section, Grandmaison et al. (2009) reported that 8% of motorists attempted to illegally collect tortoises positioned on roads in a study at 38 sites involving 474 human-tortoise interactions, and concluded that a “biologically significant” number of tortoises are collected by motorists.

Collection of tortoises as pets may not result in the mortality of the individuals collected, but once they are collected, the effect is the same, i.e., their genes have been effectively removed from the wild population.

Even if tortoises are not collected by humans, being handled by humans may result in decreased survivorship of the handled individual. Desert tortoises may be handled by humans who encounter them while recreating in the desert, while driving along roads, or conducting research activities. Berry and Nicholson (1984) report that human handling of tortoises may lead to their injury or death. Handling or restraint of desert tortoises may cause various types of responses by tortoises, including 1) physiological stress, including their ability to withstand high temperatures and voiding the contents of their bladder; 2) disrupting the tortoise so that it withdraws into its shell for a long period that would prevent it from

obtaining food, water, or cover; and 3) transmission of diseases by people handling multiple tortoises without sterilizing their hands (see review in Boarman 2002a). Tortoises are regularly handled during scientific research projects (including blood draws, attaching radio transmitters and identification tags, filing of the carapace, and weighing and measuring). Neither the short- or long-term effects of handling tortoises have been experimentally investigated in terms of changes in biochemistry, increased exposure to disease resulting from handling procedures, or changes in tortoise behavior (e.g., thermoregulation, mating, movement) immediately after handling, although Berry et al. (2002) speculated that factors exacerbating the effects of tortoise death by dehydration may have included handling and research manipulation.

In nearly all of the articles and reports cited in this section, access by humans to desert tortoise habitat is asserted as the fundamental facilitator of human take (Boarman 2002a).

Cumulative and Interactive Effects with other Threats

Disease

Collecting desert tortoises as pets may also increase the threat of introducing diseases to wild tortoise populations when unwanted animals are released back into the desert after having contracted disease from the stress of captivity or from coming into contact with other diseased, captive tortoises (Jacobson 1993).

Other Cumulative and Interactive Threats

Human access to areas inhabited by desert tortoises occurs along roads, legal and illegal OHV trails, and access roads associated with utility developments, mines, and landfills. Human access into desert habitats and collection/poaching of tortoises is likely more substantial in the vicinity of urbanized areas. Translocated tortoises wandering in search of burrows or homing to their original capture point are likely more susceptible to being collected or poached.

Distribution with Conservation Areas

Clues regarding the impact of collection of wild desert tortoises as pets from the Conservation Areas may be gleaned from various data, including local tortoise rescue groups and the Clark County Desert Tortoise Transfer and Holding Facility at the Desert Tortoise Conservation Center. The California Turtle and Tortoise Club operates an adoption program for desert tortoises, and reports adoption statistics since 1998 on its website (Figure 22). The data indicate high numbers of desert tortoise rescues in the Central and Southern California areas, but do not indicate where the animals originated; i.e., whether they were taken from the wild or were bred in captivity. Likewise, the Clark County Desert Tortoise Transfer and Holding Facility maintains data regarding the number of wild and unwanted pet tortoises that enter the facility through the Clark County pick-up service (Figures 23 and 24). Though a number of the presumed wild tortoises that enter the facility originated from land clearance surveys performed ahead of development projects in the Las Vegas Valley, some of the tortoises originated elsewhere, and may represent tortoises that were illegally collected. Despite sparse scientific data, strong anecdotal and inferential evidence suggests large numbers of wild tortoises have been and continue to be collected as pets.

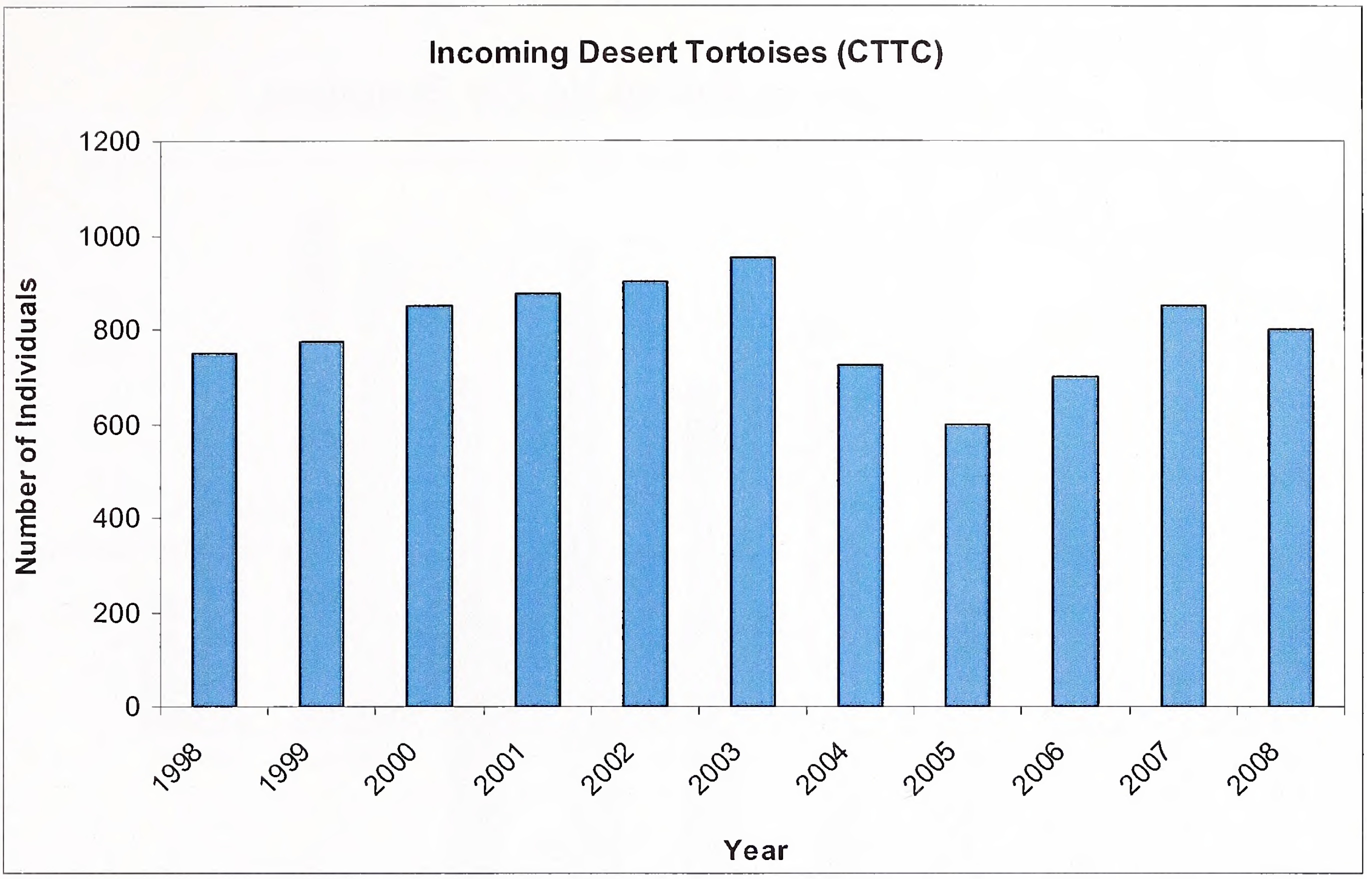

Figure 22. Numbers of Incoming Desert Tortoises to the California Turtle and Tortoise Club (CTTC) adoption Program Per Year

(Source: http://www.tortoise.org/cttc/adoption.html).

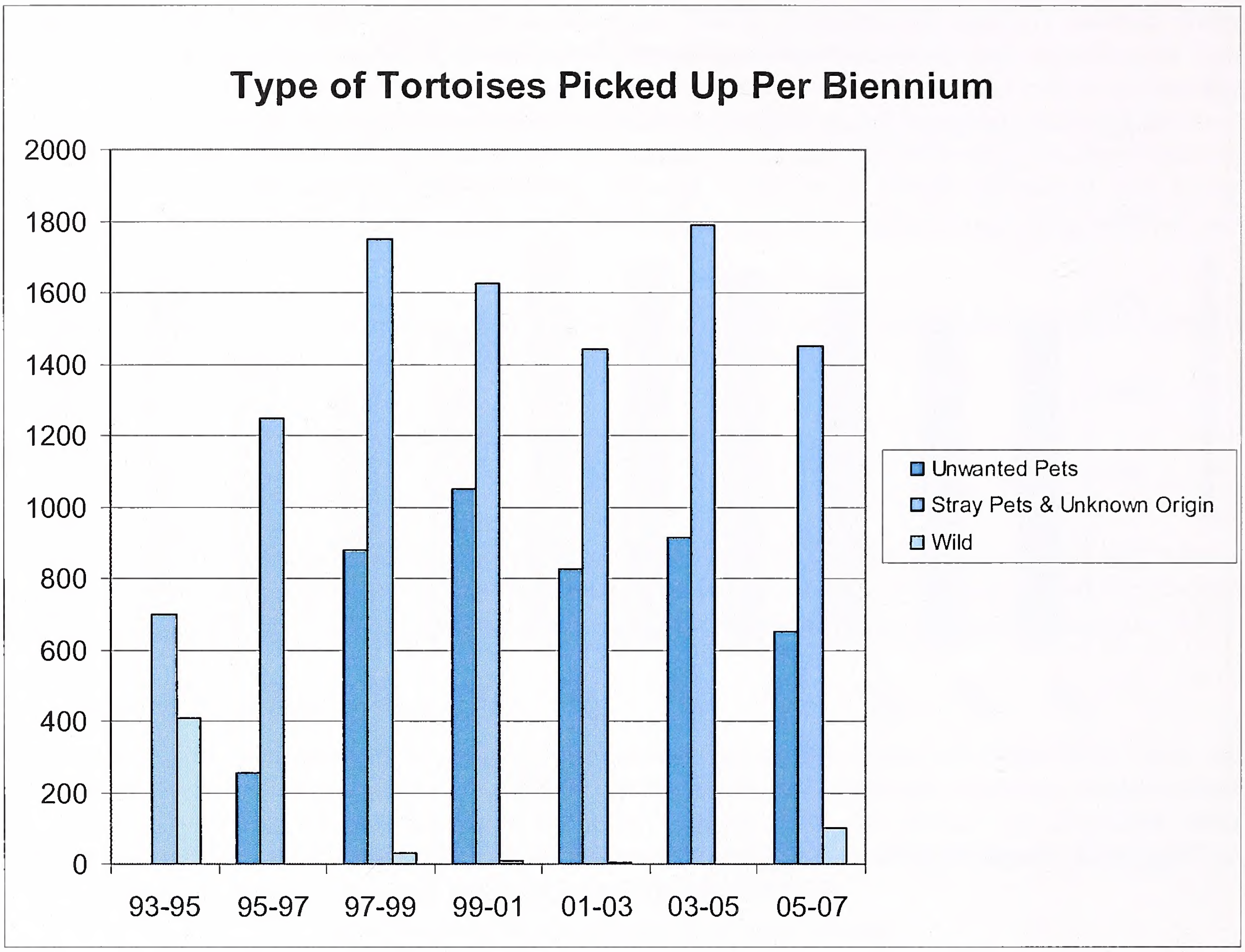

Figure 23. Numbers of Incoming Desert Tortoises to the Clark County Desert Tortoise Transfer and Holding Facility Per Year

(Source: Clark County, Nevada Desert Conservation Program 2005-2007 Biennium Progress Report).

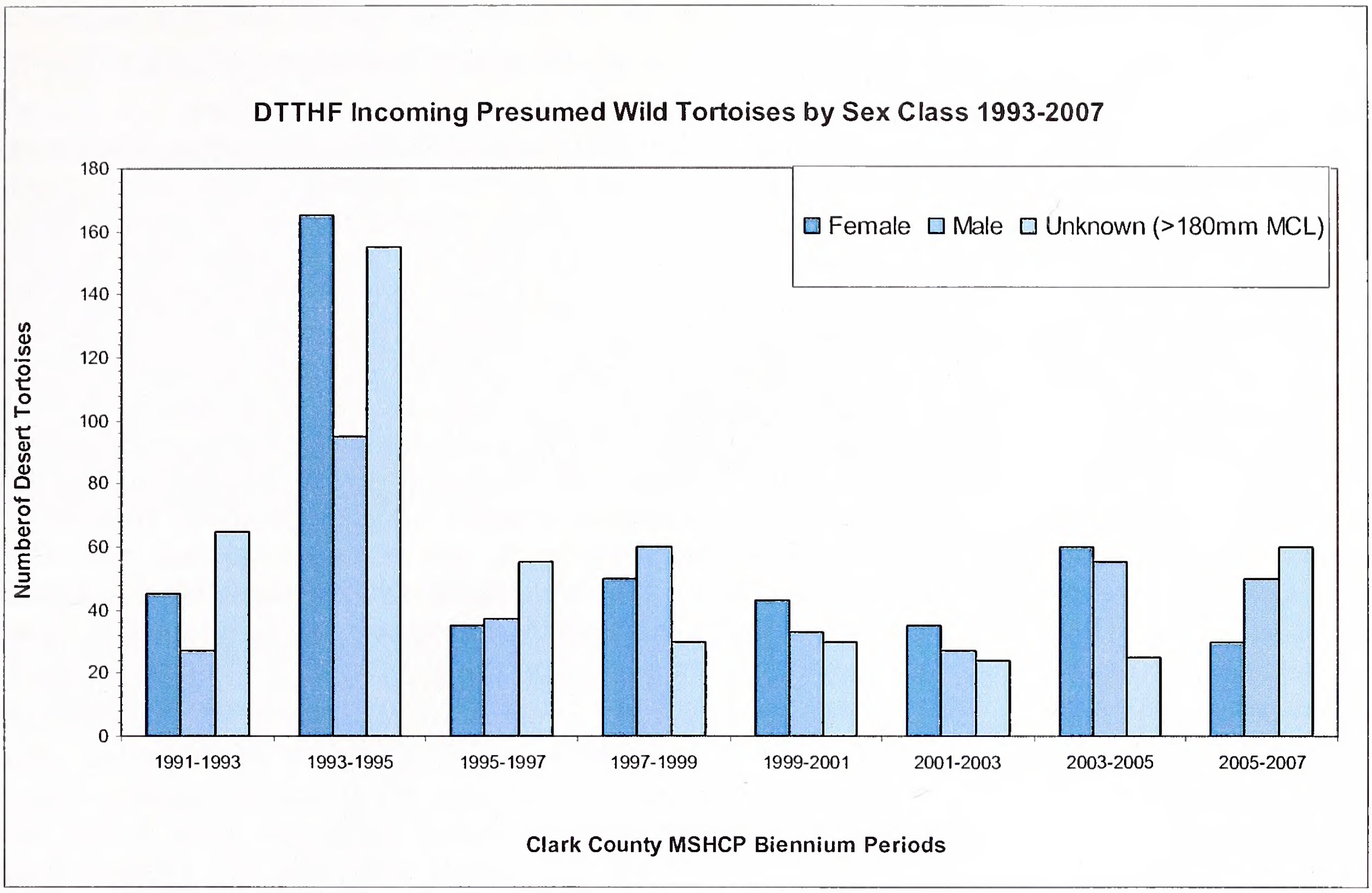

Figure 24. Sex Distribution of Presumed Wild Tortoises Entering the Clark County Desert Tortoise Transfer and Holding Facility Per Year

(Source: Clark County, Nevada Desert Conservation Program 2005-2007 Biennium Progress Report).

Translocation of Tortoise Populations

Though translocation of desert tortoise populations is employed as a tool for managing desert tortoise populations, the translocation of tortoises is not without effect. Translocated tortoises face risks associated with movement into unfamiliar landscapes, and resident tortoise populations face risks as new tortoises are introduced into occupied habitats. Translocation has been used to establish, re-establish, or augment populations in decline (Griffith et al. 1989; Dodd and Seigel 1991; Field et al. 2007; Germano and Bishop 2009), as well as to mitigate for developments or actions in desert tortoise habitat (USFWS 2004; BLM 2010). Success rates of herpetofauna translocations range from 14% to 42%, indicating that the development of improved techniques is essential if this tool is to be used as a method of species recovery (Dodd and Seigel 1991; Germano and Bishop 2009).

Impacts

Germano and Bishop (2009) reviewed 91 herpetofauna translocation projects, and determined that the most important causes of translocation failure were homing response by translocated individuals and translocation to poor habitat. Other contributors to failure included human collection, predation, food and nutrient limitation, and disease (Germano and Bishop 2009). It may be possible that – without careful design and implementation of translocation plans – desert tortoise translocation efforts could fail from these issues. Additionally, translocation of desert tortoise populations may cause elevated stress hormone levels in translocated individuals; disruption of social behavior patterns and social structure dynamics; and genetic mixing (Bertolero et al. 2007; Field et al. 2007; Rittenhouse et al. 2007; Teixeira et al. 2007).

Mortality

Translocated desert tortoises are faced with the challenge of finding food resources, retreat sites, and mates in a foreign landscape. Tortoises occupy a network of overlapping home ranges, and generally 'know' where to find food, water, mineral, shelter, and shade resources, and mates (Marlow and Tollestrup 1982; Berry 1986c; O'Connor et al. 1994). Often, the initial response of translocated tortoises is to reject the new landscape and return to its original home range. Tortoises that exhibit stronger homing tendencies are exposed to a variety of risks as they attempt to find their original home range, including heat exposure, predation, and collection/poaching by humans. Research on translocation efforts in Nevada and Utah indicated that translocated and resident tortoises exhibited comparable levels of mortality (Nussear 2004; Field et al. 2007). These studies also concluded that the increased movements initially observed in the translocated individuals decreased as the tortoises became more familiar with the translocation site over time (Nussear 2004; Field et al. 2007). However, the translocation of tortoises from the Southern Expansion Area in support of the Ft. Irwin Land Expansion project indicates that high rates of mortality may be incurred following mass translocations of desert tortoise populations. Over the first year following translocations, 25% of tortoises had died; by the end of the second year, 44% of the translocated sample died (Gowan and Berry 2010). The mortality rates of the translocated individuals were determined to be similar to the mortality rates exhibited by resident tortoises at release sites, as well as tortoises in other portions of the project vicinity, suggesting that the relocation effort per se did not affect population mortality, but rather increased predation pressure by coyotes following a drought year was more likely the cause of the increased mortality (Esque et al. 2009; Esque et al. 2010).

Disruption of Genetic and Social Structures within Populations

Translocation may have long-term genetic and behavioral consequences for both translocated and resident tortoise populations. Tortoises have an elaborate social structure mediated by relatedness, and potential genetic differences between different populations should be a major consideration of researchers and a component of the design of desert tortoise translocations (Berry 1986c; Murphy et al. 2007).

The translocation of tortoises into areas supporting low-density populations may have an overall positive effect by bolstering genetic diversity (Dodd and Seigel 1991; Letty et al. 2007; Teixeira et al. 2007). However, desert tortoises exhibit low rates of gene flow (Edwards et al. 2004), and mixing genes from one geographic area into a population from a different geographic area could produce deleterious effects through outbreeding depression, a condition that results in a reduction in fitness from mixing naturally isolated demes that are adapted to local conditions (Reinert 1991). An example of possible genetic divergence between populations occurring over fairly short geographic distances was provided by Latch et al. (2009). Latch et al. (2009) detected weak genetic separation between tortoise populations in the eastern and western portions of the Southern Expansion Area of Fort Irwin, which underscores the low rates of gene flow demonstrated by desert tortoises and suggests that genetic evolution may have occurred in response to adaptation to local conditions. Therefore, though the consequences are largely unknown, mixing genetically distinct populations during translocation efforts may be genetically deleterious.

In resident populations, the existing social dominance hierarchies, movement patterns, and home range boundaries are likely affected by the introduction of new individuals. Among the translocated population, the existing social structure is likely completely dissolved, particularly if translocated tortoises are not translocated as a group to an area devoid of resident tortoises. Long-term studies of the social structure of desert tortoises on Fort Irwin reveal that hierarchical dominance, based on a tortoises' size, past injuries, and size and shape of the gular horn, were important factors in determining shape and position of home range among both alpha and beta males. Female tortoises were also determined to have a network of overlapping home ranges in the same study (Berry et al. 2005; Berry et al. 2007). During translocation, the introduction and integration of 'foreign' adult tortoises into the resident population likely increases

antagonistic behaviors through competition for resources and mates in the short term, particularly among males. The long-term consequences are unknown.

Cumulative and Interactive Effects with other Threats

Population translocations occur in response to the human need for occupying former desert tortoise habitat. To date, the types of human activities that have necessitated tortoise translocation efforts have included urban developments, utility developments, alternative energy projects, and military activities. Evidence from the desert tortoise translocations performed in support of the Fort Irwin Land Expansion project indicates that translocations performed during or immediately following a drought will likely lead to increased failure rates as subsidized predators turn from their normal prey items to desert tortoises (Esque et al. 2009; Esque et al. 2010). Translocation of tortoises may also introduce resident populations to disease carried by translocated individuals, or conversely expose healthy translocated tortoises to diseased animals at translocation sites.

Distribution within Conservation Areas

There have been no desert tortoise translocation efforts performed within the Gold Butte-Pakoon Conservation Area, nor are there any such efforts planned there for the near future. A fairly large translocation effort was performed within the Superior-Cronese Conservation Area during the spring of 2008, and additional translocations are planned for the near future. The Fort Irwin Land Expansion project annexed 545 km2 to the existing 2,598 km2 base (Public Law 2002). This annexed land, more than half of which was within designated desert tortoise Critical Habitat, supports an estimated 2,000 desert tortoises (USFWS 1994a; Heaton et al. 2008). The expansion areas are in three distinct locations bordering Fort Irwin: the Western Expansion Area (WEA), the Southern Expansion Area (SEA), and the Eastern Expansion Area (EEA) (Figure 21). In April 2008, and more than 600 individuals were moved from the SEA to translocation sites within the Superior-Cronese Conservation Area that were located up to 35 km away from source locations (Figure 24). The WEA translocation effort, moving an estimated 1,000 tortoises, will occur in the near future (proposed 2010) (Esque et al. 2005; Heaton et al. 2008), and the tortoises located in the EEA will not translocated but instead will remain within the active range.

Heaton et al. (2008) developed a spatially explicit decision support model based on multiple habitat and conservation criteria (including land ownership, habitat, proximity to roads and urban areas) to identify the most favorable translocation sites for tortoises for the Fort Irwin expansion. The translocation sites, which are one square mile in area, were not fenced so that tortoises were able to roam freely after their translocation. Genetic separation between tortoises within the SEA, as well as between tortoises within the SEA and translocation sites, was not assessed prior to the translocation, so there may be genetic mixing at the translocation sites that could potentially lead to outbreeding depression. In addition, sex ratios were manipulated during the translocation effort. The translocated population was skewed toward males, and while many of the translocation sites received an equal sex ratio of male and female tortoises, there were multiple sites where only male tortoises were released. Thus, translocation sites that received only male tortoises would likely lead to greater risk of male-to-male antagonistic encounters between translocated and resident tortoises.

Recent and ongoing studies of the effects of the tortoise translocations from the SEA to sites within the Superior-Cronese Conservation Area appear to indicate that translocated individuals respond in one of three ways: 1) remain in close association with cover sites at or near release locations; 2) move in wandering patterns over distances of up to several kilometers for several days to weeks immediately following release, and then returning to the general vicinity of the original release site and settling within a stable home range; and 3) exhibiting homing or long-range dispersal behaviors whereby a tortoise moves quickly over several kilometers in the same general direction. Tortoises that dispersed in this

manner moved up to 5 km. Translocated tortoises fell approximately equally into each of these three response groups (D. Hinderle, pers. comm. August 2010). Thus, we estimate that tortoises translocated from the SEA dispersed distances of up to 5 km from release plots (Figure E-25 in Appendix E). Both translocated and resident tortoises within this area of predicted dispersal range from release plots would be affected.

3.3.3 Environmental and Biological Threats

Drought

Droughts are a fairly common and cyclical occurrence in the Southwest region of the United States, particularly within the Mojave Desert (Hereford et al. 2006). Quaternary paleoclimatic data indicate that the Mojave Desert experienced cycles during the Pleistocene glacial/interglacial oscillations, with of increased humidity during glacial maximums and relatively arid conditions during interglacial periods (Tchakerian and Lancaster 2002). Fluctuations in mesic conditions during the Holocene were influenced by periods of increased summer monsoonal events between 14,000-9,000 and 6,000-3,000 years ago (Miller et al. 2010). Vegetation within the Pleistocene Mojave Desert generally indicates relatively mesic conditions compared to the modern condition. The modern Mojave Desert climate appears to have been fully developed into its modern condition by around 8,700 years ago (Koehler et al. 2005). Therefore, desert tortoises have likely faced natural fluctuations in water availability throughout their most recent evolutionary history (Nagy and Medica 1986; Peterson 1994). Drought has been identified as a source of high episodic population mortality (Berry et al. 2002; Longshore et al. 2003; Peterson 1994). Though desert tortoises exhibit physiological (Peterson 1996) and behavioral (Duda et al. 1999) mechanisms for tolerating the arid Mojave Desert conditions, and can maintain negative net energy for extended periods (Longshore et al. 2003; Peterson 1996), tortoises appear to be dependent on standing sources of water to maintain positive net energy (Peterson 1996). Droughts generally cause physiological stress to tortoises (O'Connor et al. 1994), and severe droughts – especially those lasting several years – result in increased mortality rates as tortoises die from dehydration and starvation. Droughts also indirectly contribute to increased mortality rates of tortoises as predators shift their diets to more robust and available species like the desert tortoise (Peterson 1994). Some studies have also noted decreases in numbers of juvenile tortoises that appear to correspond with reduced precipitation (Corn 1994). Finally, drought reduces clutch size (Turner et al. 1986), though females are able to maintain some egg production each year, even in drought years and during periods of negative net energy (Henen 1997).

<u>Cumulative and Interactive Effects with other Threats</u>

Prior to European settlement of the desert southwest, desert tortoise populations recovered from droughts during periods of normal rainfall accumulations. However, due to the variety of recent anthropogenic threats faced by the desert tortoise – particularly those threats that reduce population size or fragment habitat – the ability of populations to recover from stochastic events such as droughts is likely greatly diminished. The effect of droughts in the context of multiple anthropogenic threats thus becomes synergistic (Peterson 1994).

Subsidized Predators

Drought can contribute to increased predation by subsidized predators. This was evident on the Fort Irwin juvenile survivorship study (M. Tuma, personal observation), Daggett epidemiology study (J. Mack, personal communication, February 2009), and Fort Irwin Translocation project (Esque et al. 2009) during the 2008 season, when coyote predation events contributed substantially to mortality of large juvenile and adult tortoises, apparently because of a shift by these predators to tortoises from jackrabbits following a significant drought event between 2006 and 2007.

Other Cumulative and Interactive Threats

Agricultural practices likely lower water tables, contributing to the frequency or intensity of droughts in localized areas. Droughts—particularly those that affect winter precipitation patterns—could become more commonplace in the future, as predicted by climate change models. Tortoises are likely to change their diet to less nutritious sources of food such as cactus and invasive plants to survive extended droughts (Peterson 1996), which may weaken their health and increase their susceptibility to disease.

Distribution within Conservation Areas

According to drought data compiled by the National Oceanic and Atmospheric Administration (NOAA) Drought Monitor (see http://drought.unl.edu/dm) over the last 10 years, droughts of varying levels of severity have been more typical for desert environments than non-drought years. Beginning in late winter 2002, a drought developed (D1 [moderate] to D2 [severe]) that became extreme (D3) in both the Superior-Cronese and Gold Butte-Pakoon Conservation Areas by June 2002 and continued until February 2003. This particular drought remained extreme in the Gold Butte-Pakoon Conservation Area until November 2004, when it finally subsided over the course of the following winter. In February 2006, the Gold Butte-Pakoon Conservation Area experienced another severe drought classified as extreme in March 2007 that lasted until December. The Superior-Cronese Conservation Area experienced a milder drought during the same period. Both Conservation Areas were designated as having a mild to moderate drought until March 2009.

When considering minimum optimal seasonal accumulations for desert tortoises (25 mm) (Redlands Institute 2004), a different pattern emerges (Figures 28–31). From 1990 to 2008, the Gold Butte-Pakoon Conservation Area generally experienced—on average across the entire area—accumulations greater than 25 mm (Figures 25 and 26). In contrast, the Superior-Cronese Conservation Area generally experienced sufficient winter accumulations (on average), but summer accumulations routinely fell below 25 mm during the same period. Moreover, two extended droughts occurred during this period, between 1992 and 1996, and again between 2001 and 2003 (Figures 27 and 28).

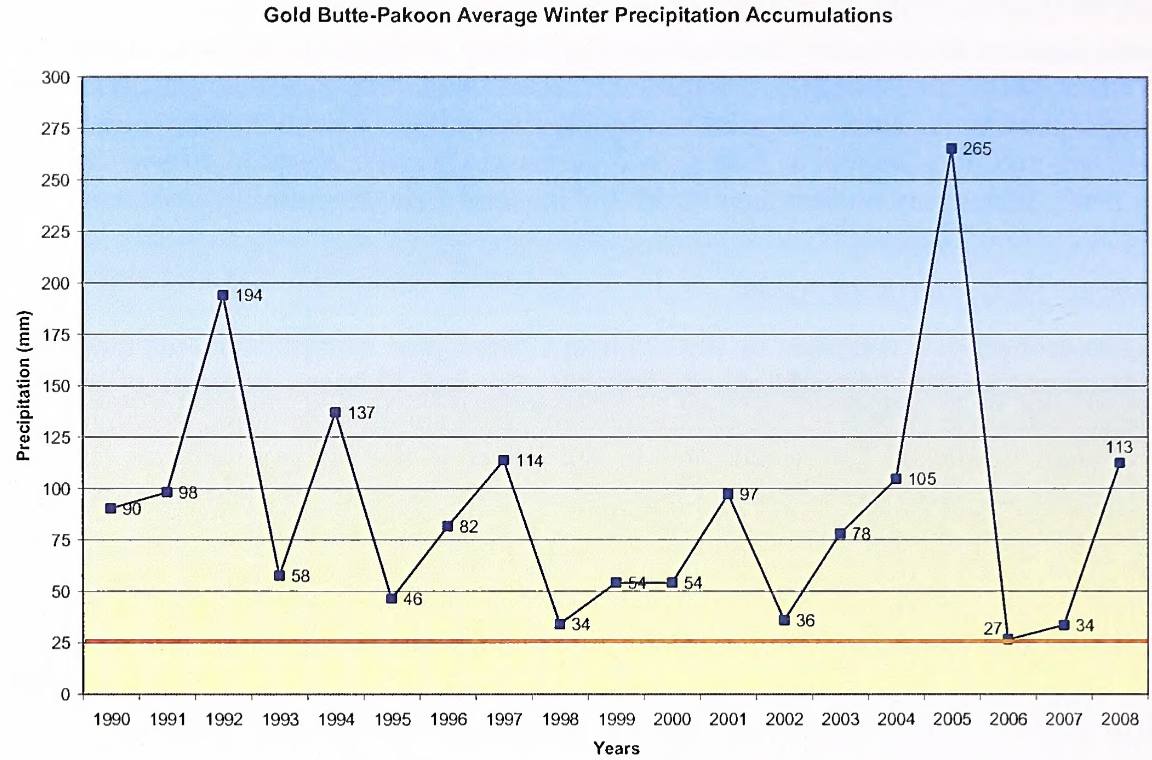

Figure 25. Average Winter Season (November–February) Precipitation Accumulations for all 4 × 4-km Cells within the Gold Butte-Pakoon Conservation Area

Accumulations above 25 mm are considered optimal for germination of annual forage plants.

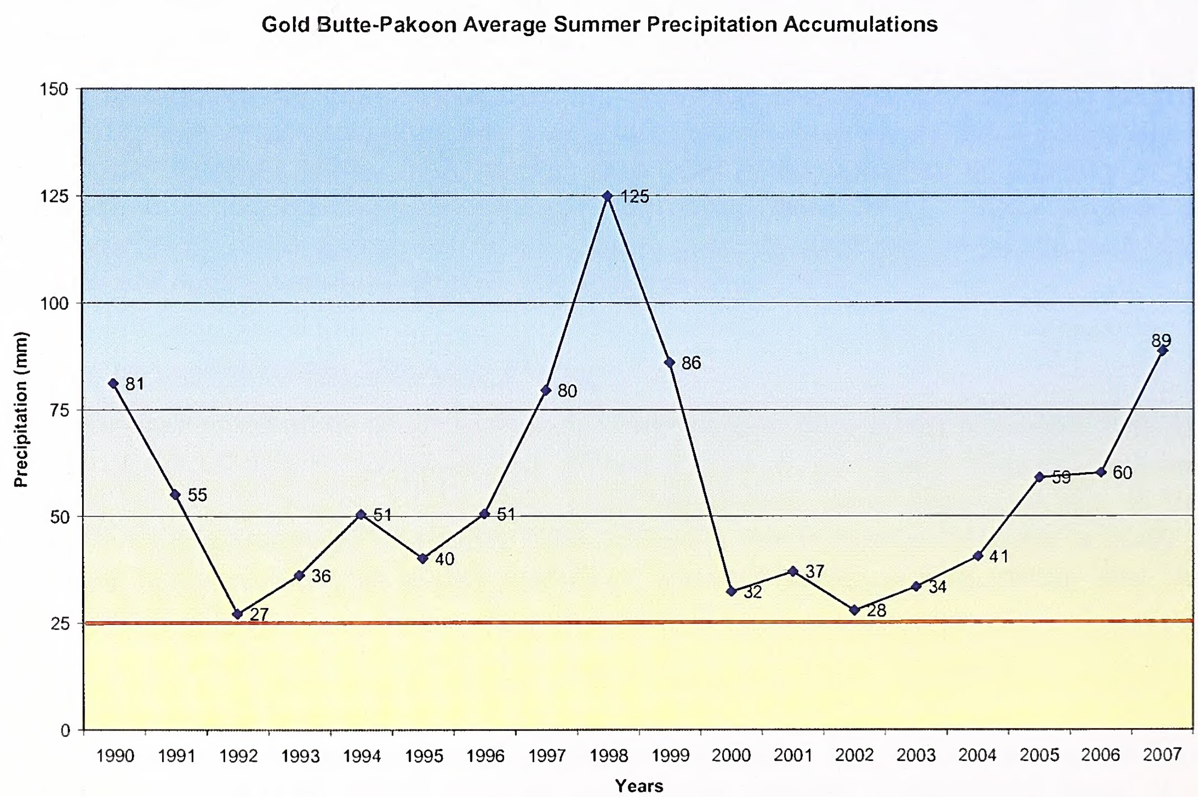

Figure 26. Average Summer Season (June–September) Precipitation Accumulations for All 4 × 4-km Cells within the Gold Butte-Pakoon Conservation Area

Accumulations above 25 mm are considered optimal for providing drinking opportunities for tortoises.

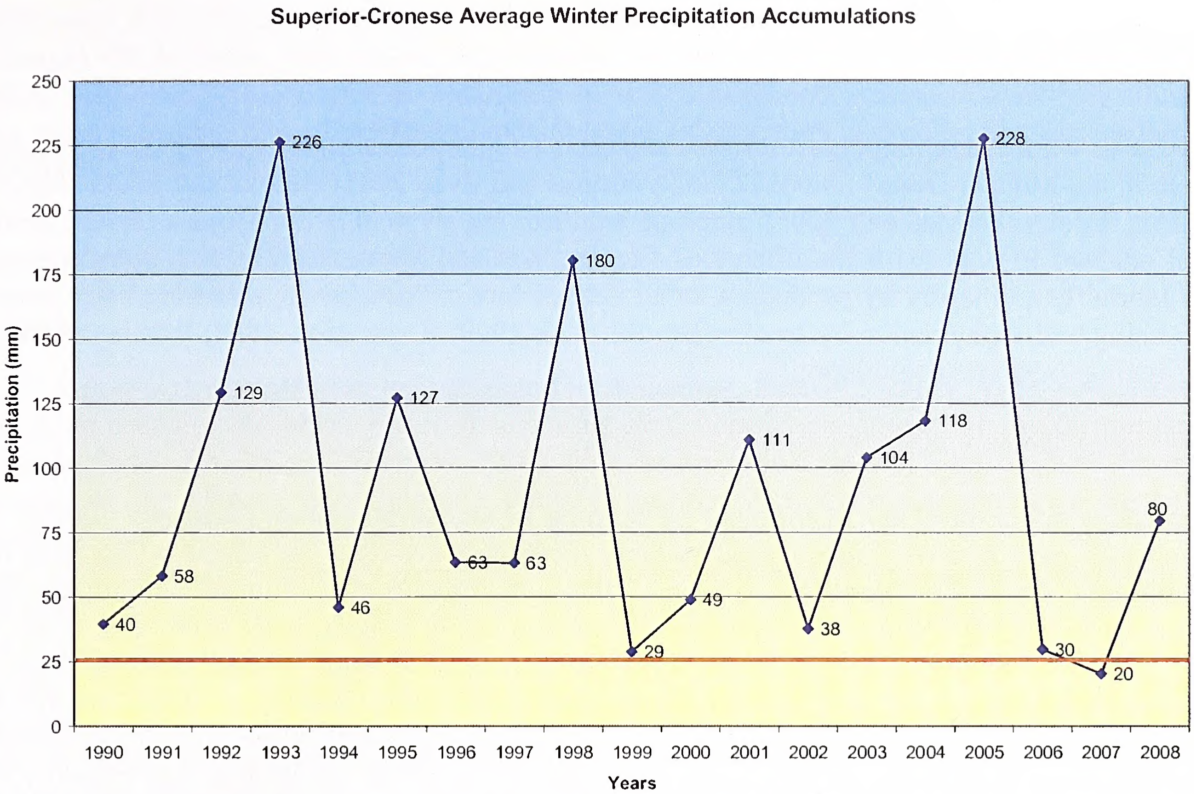

Figure 27. Average Winter Season (November–February) Precipitation Accumulations for All 4 × 4-km Cells within the Superior-Cronese Conservation Area

Accumulations above 25 mm are considered optimal for germination of annual forage plants.

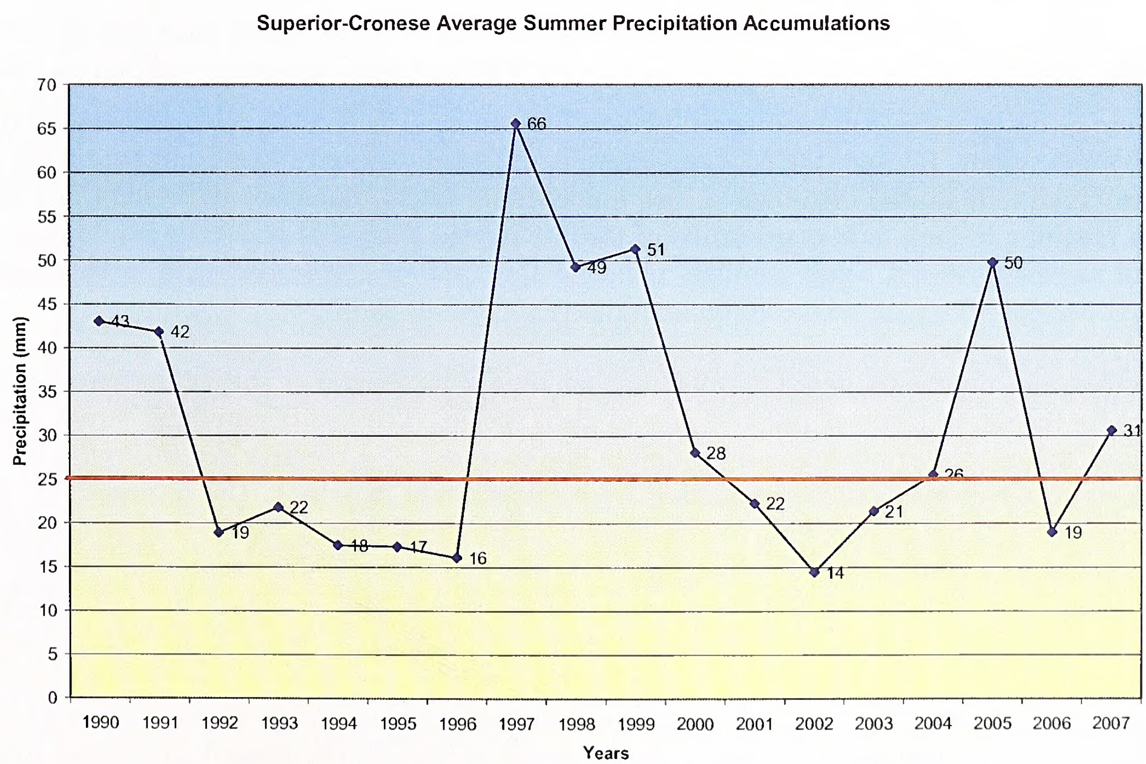

Figure 28. Average Summer Season (June–September) Precipitation Accumulations for All 4 × 4-km Cells within the Superior-Cronese Conservation Area

Accumulations above 25 mm are considered optimal for providing drinking opportunities for tortoises.

Fire

Impacts

The effects of wildfires on the desert tortoise and their habitat pose a significant threat and management challenge in the Mojave Desert (AZGFD 2009; Brooks and Pyke 2001; Brooks and Esque 2002; Brooks et al. 2004; Brooks and Matchett 2006). Because wildfires are atypical in the Mojave Desert, tortoises are not well adapted to cope with the effects of fire (Brooks and Esque 2002). Fires contribute to desert tortoise mortality and injury by producing lethal heat or low oxygen levels, elevating body temperature, and poisoning and asphyxiation by smoke (Brooks et al. 1999; Esque et al. 1994; Whelan 1995), as well as contributing to habitat degradation.

Mortality

Fire can cause direct mortality of tortoises by burning or smoke inhalation (Boarman 2002a). Because desert tortoises cannot move quickly, their primary method of avoiding the effects of fire is to retreat to an underground cover site (Brooks and Esque 2002). Burrows provide tortoise with some degree of protection from fire and deep cover sites such as caliche caves provide more protection from fire than shallow burrows. Because fire can move across a landscape at high speeds, burrows only provide protection if tortoises are in or near existing burrows at the time fires occur. Early season fires are potentially more threatening than mid- or late-season fires because tortoises are most active above ground and use relatively shallow cover sites during the spring (Esque et al. 2003), and high-intensity fires that occur when tortoises are active or occupying shallow cover sites may be particularly detrimental to tortoise populations (Esque at al. 1994). Fire suppression activities can also cause desert tortoise mortality through the accidental crushing of individuals or eggs by firefighting equipment, firefighters, or off-road vehicles, and as a result of set backfires or prescribed fires (BLM 2004; NPS 2004).

Habitat Degradation

Degradation of desert scrub habitats caused by wildfire can happen very quickly and have short term and long term implications. Because the Mojave Desert is not a fire adapted system and few desert plants are adapted to conditions of fire disturbance, fire immediately alters the desert ecosystem and recovery is very slow resulting in long-term degradation of tortoise habitat (Esque et al. 2003). In addition, fires burn hotter and farther in desert scrub habitats, reducing the natural mosaic pattern (patchy distribution of plants and open space) typical to these communities (Esque et al. 2003).

Fire degrades and fragments desert tortoise habitat by killing perennial shrubs and providing optimal conditions for the introduction of invasive annual plant species. The loss of perennial shrubs may result in an increased occurrence of predation on tortoises due to a loss of protective cover. Furthermore, loss of perennial shrub cover may reduce protection from temperature extremes. The introduction of invasive plant species changes the composition of vegetation communities, forcing tortoises to modify typical diets by incorporating less nutritious non-native plants (Brooks and Esque 2002; Esque et al. 2003). Short-term post-fire effects can include reduced availability of food plants, loss or reduction of available nutrients and trace elements, and change in seasonal availability of food plants (Nagy et al. 1998). The long-term effects include a change in community structure that includes increases in the biomass of non-native annual grasses, little shrub cover, and a reduction in native annual plant biomass (Brooks and Esque 2002). Recurrent fire can convert native desert scrub to non-native annual grasslands (Brown and Minnich 1986; Duck et al. 1997; Esque et al. 2003), which are prone to additional recurrent fires because non-native annual grass species often increase in dominance after fire (D'Antonio and Vitousek 1992; Jennings 1997b). Landscape-level changes have the potential to reduce the local availability of suitable habitat and may introduce barriers to animal movement, causing fragmentation of habitat, thus reducing the ability of tortoises to find mates and possibly altering population structure over time (NPS 2004).

Fire suppression activities can cause degradation or loss of key habitat components (e.g., perennial shrub cover, forage) (BLM 2004; NPS 2004). Suppression can also cause habitat degradation resulting from firefighting activities. These activities contribute to soil disturbance, compaction of soil along travel corridors, chemical alteration of substrate, and increases in predation and collection due to the loss of cover (BLM 2004; NPS 2004).

Cumulative and Interactive Effects with other Threats

Invasive Plants

Invasions by non-native vegetation may change the frequency, intensity, extent, type, or seasonality of fire, and these changes can either result in increased or decreased prevalence of fire on the landscape (Brooks et al. 2004; Brooks and Matchett 2006). Non-native annual grasses alter the fuel structure and fire behavior in the Mojave and Colorado Deserts, making them more susceptible to frequent fires (Brooks and Esque 2002). Abundant fuel loads place desert tortoises at increased risk from fire (Brooks and Esque 2002), a situation that is exacerbated by the introduction of invasive plants. Areas that support invasive annual grasses such as cheatgrass, bromes, and Mediterranean grass are characterized by high abundance and cover of standing dead stems that create a continuous fuel bed, facilitating the spread of fires (Duck et al. 1997; Esque et al. 2003). Because post-fire landscapes provide opportunities for invasion by non-native plants, particularly those plants that increase fuel loads, and because the presence of non-native plants increases the likelihood, intensity and extent of wildfires, a positive feedback loop may develop that ultimately increases the distribution and abundance of non-native invasive plants and wildfire frequency.

Other Cumulative and Interactive Threats

Small fires originate near urbanized areas and roads, whereas larger wildfires that occur in remote areas are typically caused by lightening (Brooks and Esque 2002). The effects of climate change are expected to increase the frequency of summer monsoons, which may contribute to increasing numbers of wildfires caused by lightning strikes. Large wildfires contribute to poor air quality. Military activities, and OHV use and other recreational activities likely contribute to the incidence of wildfire events.

Distribution within Conservation Areas

Table 10 summarizes fire occurrences in the Gold Butte Pakoon and Superior Cronese Conservation Areas between 1990 and 2008 (see also Figures D-22 and D-23 in Appendix D). Fire has occurred more regularly, and over larger areas, and as such is a more serious threat within the Gold Butte-Pakoon Conservation Area than the Superior Cronese Conservation Area. Using remote sensing techniques, we detected widespread areas where fires have cleared vegetation cover within the Gold Butte-Pakoon Conservation Area (Figures 29-31; Figure E-8 in Appendix E). Patterns of fire in the Gold Butte-Pakoon area has varied widely over the period from 1990 to 2008, ranging from no fires in some years to frequent and extensive fires in other years. During this period a total of approximately 210,000 acres have burned within the Gold Butte-Pakoon Conservation Area. Fire frequency and extent of fire damage was relative low in the Gold Butte-Pakoon Conservation Area during the 1990s, ranging from several hundred acres to just over 12,000 acres burned a year between 1990 and 1995. Fire frequency was low during 1996, but two large fires resulted in more than 20,000 acres of burn area during that year. No record of fires was found between 1997 and 2000. From 2000 to 2004 fire frequency and extent was very low in the Gold Butte-Pakoon area with only three recorded fires, the largest of which burned just over 2,000 acres. The Gold Butte-Pakoon area saw a significant increase in the frequency of fires during 2005 and 2006 with 13 recorded fires (26 total fires) in 2005 and 2006. Fires in 2006 were relatively small in extent having a total burn area of approximately 10,000 acres; however, fires during 2005 were very large totaling

approximately 140,000 acres. We would characterize fire as a severe threat in the Gold Butte-Pakoon Conservation Area because tortoises are absent from several areas within the Pakoon Basin that have burned repeatedly (USFWS 1996a). Compared to the Pakoon Basin, fire appears to be a less severe threat to tortoise populations inhabiting the Superior-Cronese Conservation Area. Between 1990 and 2008 only 4 fires were reported for the Superior Cronese Conservation area totaling approximately 380 acres, and 3 of these fires occurred in 2005.

Table 10. Summary of Fires within the Conservation Areas between 1990 and 2008

Fire Name	Year	Acreage
Superior-Cronese		
Opal	2005	131.1
Grasshopper	2005	180.6
Husky Fire	2005	40.7
	2005 total acres burned	**352.4**
Fremont	2007	31.8
	2007 total acres burned	**31.8**
	1990-2008 Total Acres Burned	**384.2**
Gold Butte-Pakoon		
Frehner	1992	362.4
	1992 total acres burned	**362.4**
Cedar Wash	1993	5,208.5
Cottonwood	1993	1,823.4
Wedding	1993	8.8
Pakoon	1993	1,129.6
Balanced Rock	1993	12.0
Middle Well	1993	729.7
	1993 total acres burned	**8,912.0**
Cottonwood	1994	1,187.9
Wayne	1994	158.2
Elbow	1994	10,481.8
Grand	1994	397.8
	1994 total acres burned	**12,225.7**
Big Hole	1995	214.3
Airstrip	1995	448.0
Tasteful	1995	2,103.5
Savanic	1995	1,634.0
Tank	1995	2,352.9
N. Gulch	1995	691.8

Table 10. Summary of Fires within the Conservation Areas between 1990 and 2008

Fire Name	Year	Acreage
Olaf	1995	148.4
Jacob Well	1995	240.6
Littlefield	1995	617.7
Pigeon	1995	134.9
Mud	1995	2,406.5
	1995 total acres burned	**10,992.6**
071296	1996	87.6
Gulch	1996	11,538.4
Ring Tank	1996	11,494.4
Glo	1996	36.5
	1996 total acres burned	**23,156.9**
Grand	2001	205.9
Black Cyn2	2001	26.4
	2001 total acres burned	**232.3**
Nickel	2004	2,611.0
	2004 total acres burned	**2,611.0**
Bunkerville	2005	3,072.5
Tramp	2005	26,304.8
Fork	2005	59,726.6
Boulder	2005	158.3
Mt. Bangs	2005	10,405.0
Cow	2005	20,299.9
Tweedy Complex	2005	2,210.0
Cedar Wash	2005	475.6
Brumley	2005	578.6
Jacob	2005	2,467.4
Cockscomb	2005	182.7
Tank	2005	13,358.4
Nevershine	2005	624.4
	2005 total acres burned	**139,864.2**
Veteran	2006	141.2
Kiln Complex	2006	1,091.3
Pocket Complex	2006	5.1
Pocket Complex	2006	4,798.9

Table 10. Summary of Fires within the Conservation Areas between 1990 and 2008

Fire Name	Year	Acreage
Pocket Complex	2006	724.5
Jacob	2006	2,736.6
Waynes Well	2006	17.6
Olaf	2006	72.8
Birthday Complex	2006	726.3
Snap 2	2006	57.0
Cabin	2006	49.1
Double Nickel	2006	334.8
Virgin Gold	2006	5.1
	2006 total acres burned	**10,760.3**
Lime	?	15.9
	1990-2008 Total Acres Burned	**209,133.3**

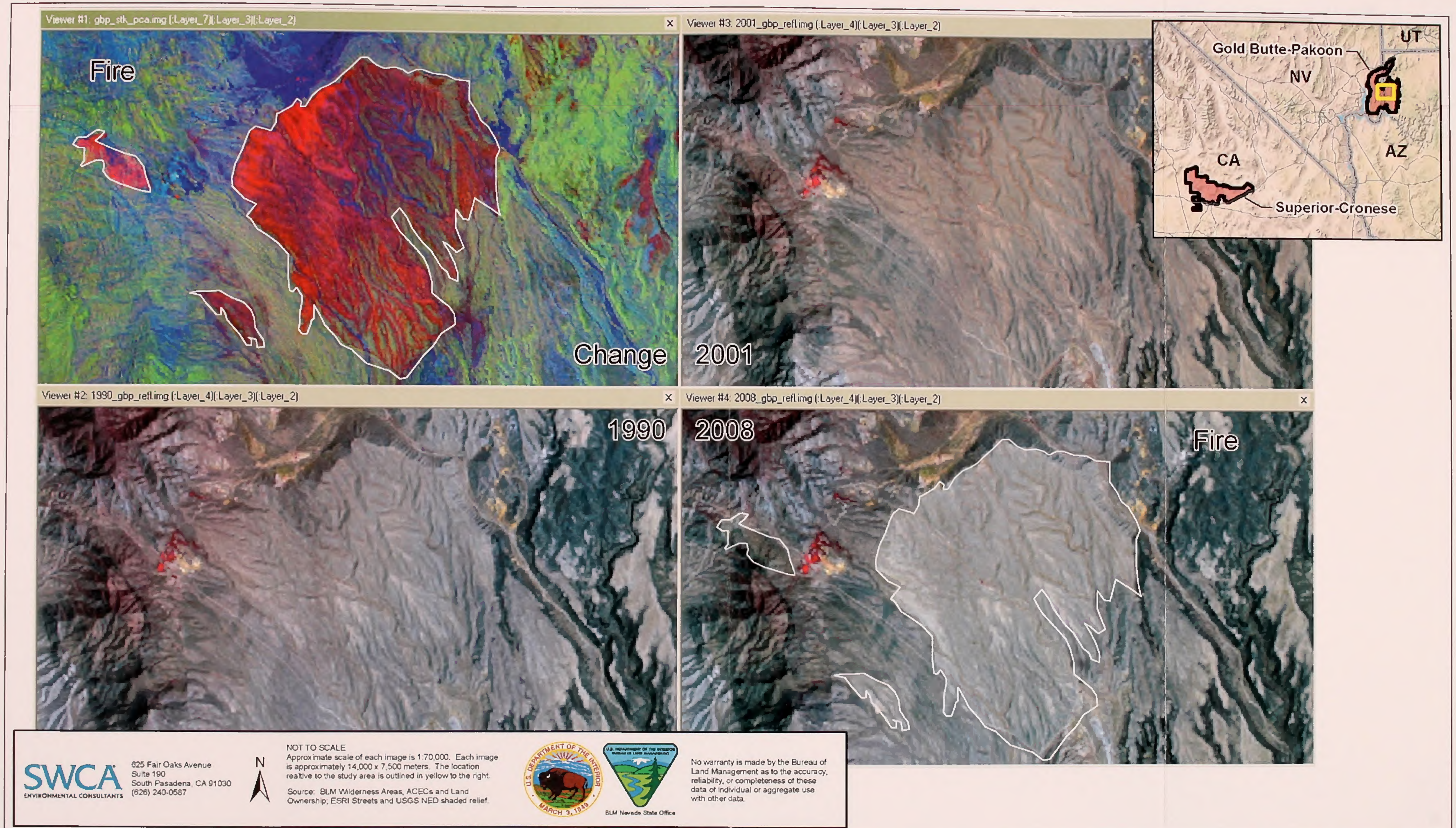

Figure 29. Remotely Sensed Fire

The remotely sensed change image (upper left) shows several dark red features representing vegetation removal within the Gold Butte-Pakoon Conservation Area between 1990 (lower left), 2001 (upper right), and 2008 (lower right). None of these disturbances were present in 1990 (lower left) imagery. Some of these features correspond with mapped fire perimeters.

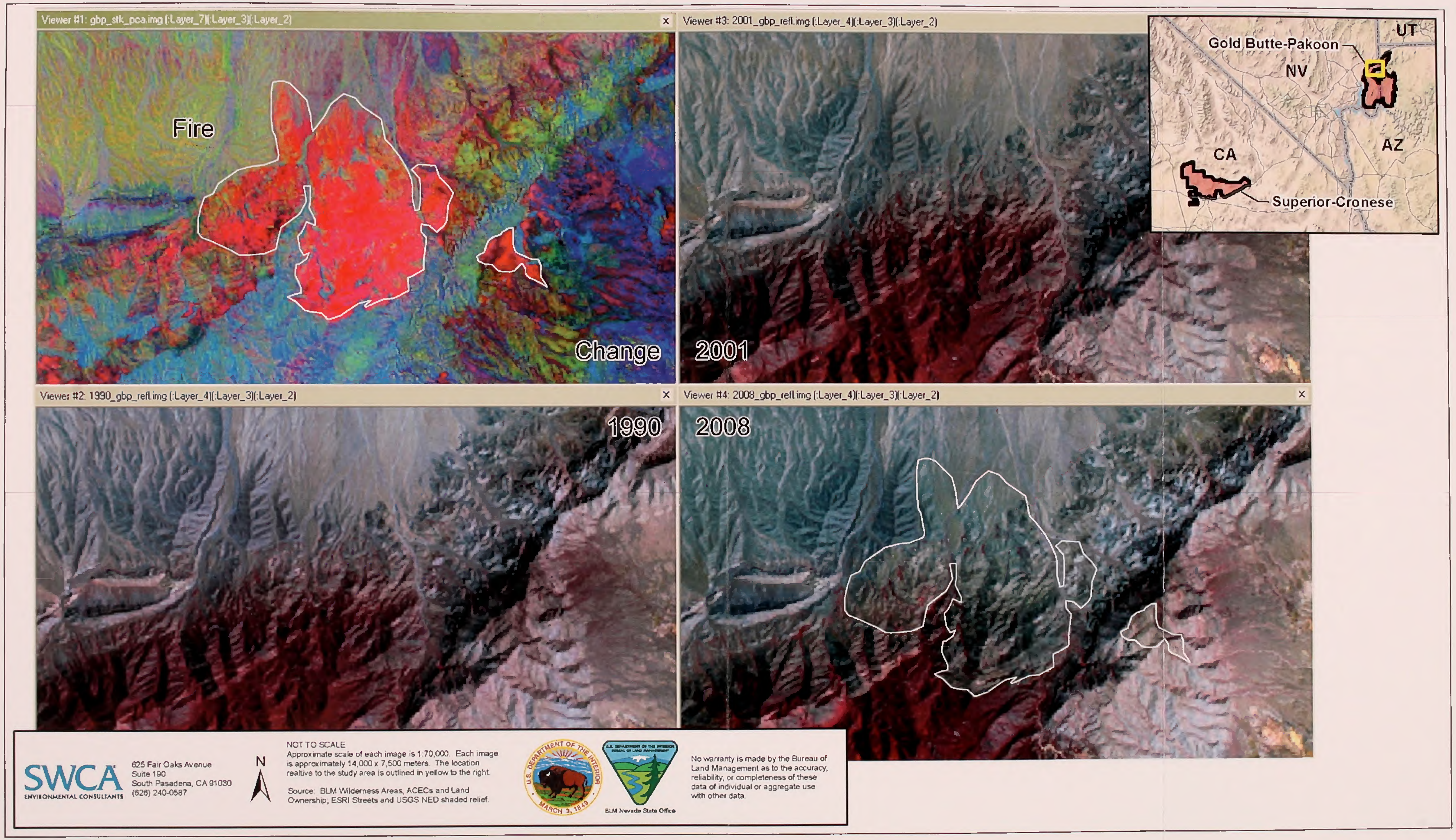

Figure 30. Remotely Sensed Fire

The remotely sensed change image (upper left) shows several dark red features representing vegetation removal within the Gold Butte-Pakoon Conservation Area between 1990 (lower left), 2001 (upper right), and 2008 (lower right). None of these disturbances were present in 1990 (lower left) imagery. Most fire-related changes appear to have occurred between 2001 and 2008.

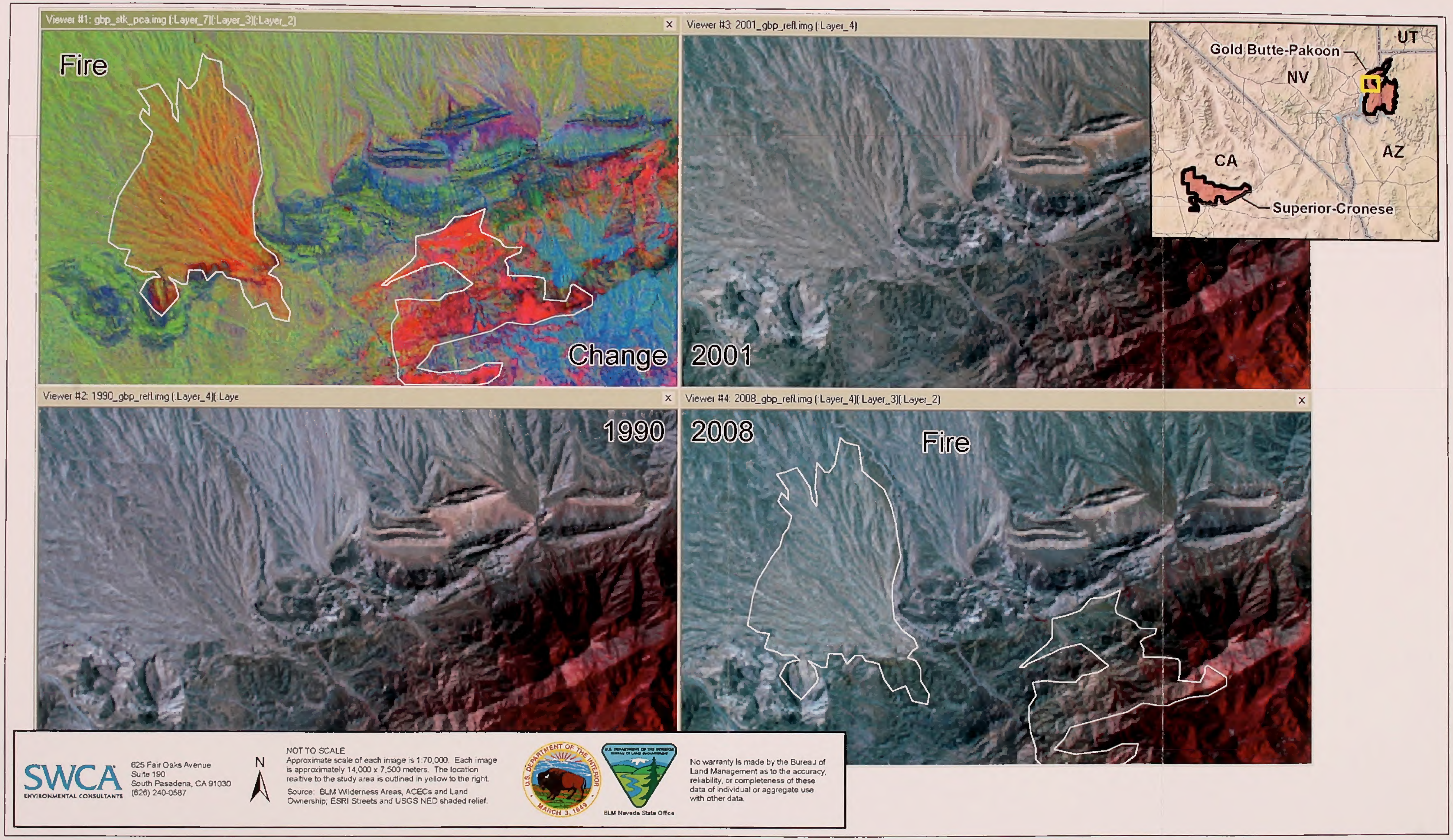

Figure 31. Remotely Sensed Fire

The remotely sensed change image (upper left) shows several dark red features representing vegetation removal within the Gold Butte-Pakoon Conservation Area between 1990 (lower left), 2001 (upper right), and 2008 (lower right). None of these disturbances were present in 1990 (lower left) imagery. Most fire-related changes appear to have occurred between 2001 and 2008.

Disease

In the early 1980s, researchers began noticing precipitous declines in wild desert tortoise populations that coincided with the presence of a previously undocumented respiratory illness, URTD. Symptoms of the illness, while not always present, include ocular discharge, swollen eyelids, nasal exudate, wheezing or rasping breathing patterns, and overall lethargy that may lead to anorexia and dehydration. By 1994, it was determined that the illness they were observing in these tortoises was caused by an infection with the bacterium *Mycoplasma agassizii* (Brown et al. 1994). *M. agassizii* is transmitted among tortoises via close contact, either face to face or at shared features such as burrows. Thus, adult tortoises of reproductive age are most likely to transmit URTD to one another during courtship visits and mating, as well as during male-male territorial combat (Wendland et al. 2006). Little is known about the transmission of URTD to juvenile tortoises. Since tortoises of pre-reproductive age rarely travel and visit with other tortoises, it has been assumed that they are less likely to become infected or to transmit the bacteria (Wendland et al. 2006). Data regarding vertical transmission of the bacteria from infected females to their eggs indicates that while hatchlings have maternal antibodies against *M. agassizii* upon hatching, they are not infected with the bacteria, and the maternal antibodies eventually become undetectable (Schumacher et al. 1999).

The Daggett epidemiology project, funded as a mitigation measure for the Ft Irwin Land Expansion project, seeks to provide information regarding the spread of disease within populations and across landscapes. In 2008, 197 health evaluations were conducted, revealing 25% to 45.2% exposure to *M. agassizii* and *M. testudineum* respectively, in a disturbed "core" area adjacent to Interstate 40 and a small urbanized development. The spread of disease from this area was tracked over two years, and clinical signs of URTD spread to outlying locations over the period of the study. Mack and Berry (2009) surmised that the rapid spread of the disease within the population was facilitated by overlapping home ranges and the social nature of these animals.

Impacts

Though the USFWS (1994a, 2008b) considers disease as one of the top four causes contributing to the decline of wild desert tortoise populations, the level of threat has not been clearly defined. In fact, while URTD has been implicated by several researchers (Jacobson et al. 1991, 1996; Berry 1997) as the cause of a number of high mortality events in desert tortoise populations, particularly in the Western Mojave Desert. Boarman (2002a) warns that a wide range of variables can influence these die-off events, including drought, lack of food sources, predation, anthropogenic stressors, and other pathogenic infections such as herpesvirus and cutaneous dyskeratosis. Therefore, while the potential for disease to be a threat to desert tortoise populations certainly exists, there is a wide variety of factors that confounds determining the exact level of the threat, such as population size, sex ratio and age distribution of the population, and the population's proximity to other threats, such as roads and urbanized areas. In addition, questions still exist regarding what it means for a tortoise to be infected with the bacteria, what it means for a tortoise to simply show signs of being exposed to the bacteria (i.e., a positive enzyme-linked immunosorbent assay [ELISA] test), if it is safe to release previously exposed asymptomatic tortoises back into wild populations, how quickly the infection spreads through a native population, and if tortoises can ever fully recover from URTD and be deemed "healthy" again.

Cumulative and Interactive Effects with other Threats

Invasive Plants

There appears to be a link between invasive plants, toxins, and the incidence of disease. Jacobson et al. (1991) studied URTD and found high concentrations of mercury and iron in the livers of ill tortoises. He hypothesized that tortoises may become ill due to nutritional deficiency from habitat degradation and reduced forage quality in the Mojave, which led to further research on the role of toxins in forage plants and whether they affect tortoise nutrition. Non-native grasses such as *Schismus* spp. may contain higher levels of metals compared with natives (Avery 1998; Jennings 1997b). Jennings (1997b) concluded that toxicants, nutritional deficiencies, or nutritional deficiencies induced by toxicants are the most likely cause of disease in desert tortoise and that invasive plants may be a pathway for toxicants.

Collection of Tortoises

Human collection of tortoises—specifically as pets—may contribute to the spread of disease among wild populations, particularly when infected captive tortoises are released into desert environments. Johnson et al. (2006) tested blood samples for URTD (n = 179) and herpesvirus (n = 109) from captive tortoises found near Barstow and Hesperia, California. Demographic and health data were collected from the tortoises, as well as data on other reptiles housed in the same facility. Of these, 45.3% showed signs of mild disease, 16.2% showed signs of moderate disease, and 4.5% showed signs of severe disease; blood tests revealed that 82.7% of tortoises had anti-mycoplasma antibodies, and 26.6% had anti-herpesvirus antibodies (which means the tortoises were seropositive for these two diseases, and thus indicate previous exposure to the causative agents). With an estimated 200,000 captive desert tortoises in California, their escape or release into the wild is a real threat to uninfected wild populations of tortoises. Projections from this study suggest that approximately 4,400 tortoises could escape from captivity in a given year, and with an 82% exposure rate to URTD, the wild population may be at greater risk than previously thought (Johnson et al. 2006).

Other Cumulative and Interactive Threats

Studies indicate that the incidence of disease in tortoise populations in the Western Mojave increases near human developments, including primarily urbanized areas, roads, and military bases. Berry et al. (2006) conducted studies on Fort Irwin and found that the presence of infectious disease in tortoises was negatively correlated with distances from military offices, the cantonment area, and paved roads. Wildlife diseases typically emerge from anthropogenic sources that produce environmental change, such as agriculture, the introduction of invasive species, and human and domestic animal encroachment into wildlife habitats (Daszak et al. 2001; Vitousek et al. 1997). Poor air quality, toxins, pollutants, and droughts may contribute towards higher incidence of disease, or severity of the expression of the disease in individual tortoises.

Distribution within Conservation Areas

Disease occurrence and causation within the Western Mojave is generally far better understood than for other Recovery Units, including the Northeast Mojave. Similarly, the link between population decline and disease is stronger within the Western Mojave than for other Recovery Units. For example, tortoise populations within PSPs at the Desert Tortoise Natural Area (DTNA) experienced a 76% decline in the tortoise population, including a 90% decline in adults, from 1979 to 1992; this decline was specifically attributed to the presence of URTD (Berry 1997). Peterson (1994) later found that desert tortoises living at the DTNA experienced another mortality event, primarily as a result of coyote predation, but alluded to the fact that disease could not be discounted since symptomatic tortoises had been identified previously on that site.

Disease was suspected on PSPs within the Gold Butte-Pakoon Conservation Area in the 1990s (Walker and Woodman 2001; Goodlett and Woodman 2003), though this observation was never confirmed with disease testing. LDS transect surveys in the Conservation Area indicated that from 2001 to 2005, a maximum of only 10 live tortoises were observed on transects in Gold Butte during any single season (USFWS 2006a). It is possible that disease played a role in population declines there, and it is critical for research to be conducted to determine why larger tortoise populations do not inhabit the area and if there is any connection between the small population size and potential disease factors, including die-offs from URTD and other bacterial, viral, or parasitic infections.

We predicted areas of higher disease incidence within each of the Conservation Areas by placing a buffer around features that have been implicated in higher disease incidence within tortoises. These included urban developments, office buildings, paved roads, and military use areas (following Berry et al. 2006; Mack and Berry 2009) (Figures E-9 and E-26 in Appendix E).

Subsidized Predators

As human populations in desert areas have grown and human use of the desert intensified in recent times, subsidized predators have emerged as a major threat to desert tortoise populations. Boarman (1993) defines subsidized predators as "predator populations that survive and perhaps grow, in part, because of food, water, or other limiting resources provided by or associated with human activities."

<u>Impacts</u>

Mortality

The most important subsidized predators that regularly prey on or injure desert tortoises include common ravens, coyotes, and feral dogs. In addition, though not as significant a threat, golden eagles may also be considered subsidized predators. This species is known to nest on transmission line towers and prey on desert tortoises (Berry 1985), but it depends on anthropogenic activities far less than other subsidized predators and likely has a relatively minor effect on desert tortoise populations. The remainder of this section focuses on the effects of common ravens, coyotes, and feral dogs on desert tortoise populations.

Coyotes and Feral Dogs

Relatively little is known about the level of impact that coyotes and feral dogs have on desert tortoise populations. Coyotes appear to have a greater effect on desert tortoise populations during drought years. This was evident on the Fort Irwin juvenile survivorship study (Tuma, personal observation), Daggett epidemiology study (J. Mack, personal communication, February 2009), and Fort Irwin Translocation project (Esque et al. 2009; Esque et al. 2010) during the 2008 season, when coyote predation events contributed substantially to mortality of large juvenile and adult tortoises, apparently because of a shift by these predators to tortoises from jackrabbits following a significant drought event between 2006 and 2007. Coyotes frequent landfills (Boarman et al. 2006), and populations in the vicinity of landfills and urban areas may be enlarged due to the subsidies. Feral dog attacks on desert tortoises, including destruction of burrows and killing and injury of tortoises, have been documented on PSPs as early as the 1970s (USFWS 1994a). Tortoise populations on some PSPs contained high percentages of individuals that exhibited signs of canid attack, including a PSP in Lucerne Valley, California where 80% of the tortoises exhibited signs of dog attack (USFWS 1994a).

Common Ravens

Perhaps the most notorious and well-studied subsidized predator is the common raven. According to historical accounts, ravens were relatively rare in the Mojave Desert in the 1920s through the 1940s (Boarman 1993). However, as human populations grew and human activities increased in the Mojave Desert over the last several decades, common raven populations flourished. Boarman and Berry (1995) reported a 10-fold increase in the number of common ravens in the Mojave Desert between 1968 and 1992. Breeding Bird Surveys performed by the USFWS from 1968 to 1988 yielded a 1,528% increase in raven numbers in the Mojave Desert (USFWS 1994a). The increase in common raven populations has been directly attributed to anthropogenic activities and habitat alteration (Boarman 1993). Overall, an increase in resources available to common ravens helps to perpetuate populations and increase range sizes (Boarman et al. 2006). Ravens exhibit increased population sizes in areas with high human activity versus low human activity (Boarman 1993; Kristan and Boarman 2003; Boarman et al. 2006). The resources ravens acquire from anthropogenic sources lead specifically to increased juvenile survival and increased productivity in areas closer to human subsidies (Webb et al. 2004). Second-year birds were more common than adults at the landfill on Fort Irwin (Boarman et al. 2006). Anthropogenic subsidies are perhaps most important for these younger birds that would perish if dependent on natural resources alone.

Perhaps the most important way in which human activities subsidize common raven populations is by providing food and water in an otherwise barren, arid environment (Webb et al. 2004). Human activities and development can subsidize common ravens in a number of other ways, from providing perches, nesting substrates, and even relief from inclement weather (Berry 1985; Boarman 1993, 2002b, 2003; Boarman et al. 1995, 2006; Kristan and Boarman 2003; Boarman et al. 2006). In general, common ravens are highly associated with humans and benefit greatly from anthropogenic activities.

Food and Water Subsidies. Anthropogenic food sources that subsidize ravens include landfills, urban settings, and roads. Ravens are opportunistic feeders, and trash can regularly be found in raven pellets, specifically when nests are close to human activity (Kristan et al. 2004). Landfills provide one of the best subsidized food sources for common ravens, especially during harsh winter months and hot summers when natural food sources are low (Boarman 1993, 2002b). It is thought that the highest concentrations of common ravens occur at landfills (Boarman and Coe 2000). One study by Boarman et al. (2006) on Fort Irwin showed that raven abundance was higher at the Fort Irwin landfill than any of the nine other study sites. Boarman et al. (1995) found the same pattern at Edwards Air Force Base, where ravens were more common at the landfill than any other resource. And because ravens can cover as much as 65 km/day, a landfill can attract ravens from a broad-ranging area (Boarman 2002b). Boarman et al. (1995) observed that 90% of telemetered raven relocations were within 4.46 km of anthropogenic resource subsidies (landfills) in the west Mojave Desert. Similarly, coyotes regularly visit landfills, and their presence at the Fort Irwin study sites was positively correlated with common raven abundance (Boarman et al. 2006). It is thought that ravens have a commensal relationship with coyotes because coyotes can tear open garbage bags and dig up trash that ravens would otherwise be unable to access (Boarman 2002b; Boarman et al. 2006).

Paved roads with fast-moving automobiles have increased the frequency with which animals are struck and killed, thereby providing additional food sources for the common raven (Berry 1985). It has been suggested that raven nests along highways can be perpetuated because they provide a reliable source of food (Boarman 2002b). A recent study, however, showed that ravens do not actually show any significant preference for nest sites along highways, possibly because roadkill events are subject to seasonal fluctuations and occur inconsistently along any given stretch of highway (Kristan et al. 2004).

Because the Mojave Desert is incredibly dry, anthropogenic water sources are a very important resource used by common ravens. Ravens can use irrigated fields, cattle troughs, gutters, reservoirs, sewage

containment sites, golf course ponds, and leaky faucets (Boarman 1993, 2002b; Boarman et al. 1995). Of the 10 study sites at Fort Irwin analyzed by Boarman et al. (2006), the sewage treatment plant yielded the second-highest abundance of common ravens, behind the landfill site. This same pattern was noted at the Edwards Air Force Base (Boarman et al. 1995).

Nesting/Perching Structures. Ravens regularly use transmission poles, buildings, and billboards as nesting substrates, especially in areas that are otherwise void of much vertical structure (Boarman 1993). However, though regularly used by common ravens, anthropogenic nest substrates do not significantly increase fledgling survival (Webb et al. 2004).

Structures like fence posts, buildings, and telephone poles provide perches for ravens (Berry 1985), and are thought to increase visibility for hunting while reducing energy expenditure (Boarman 1993). Ravens perch along utility structures to scan for carcasses on adjacent roads (paved and unpaved) (Knight and Kawashima 1993). A study of the Desert Tortoise Natural Area yielded disproportionate distribution of tortoise carcasses at wooden posts along the perimeter of the preserve (Berry 1985).

Effect on Tortoise Populations. Ravens are known to prey specifically on neonate and juvenile tortoises with shells that have not had time to harden (Berry 1985). Berry (1985) reported seeing juvenile tortoise remains beneath five of twenty raven nests, and reported that for 279 carcasses that could be attributed to raven predation, all of the carcasses were juveniles less than 110 mm in length. Breeding ravens are particularly effective predators of juvenile tortoises. Woodman and Juarez (1988) collected 250 tortoise remains from a nest and associated perch site in the Kramer Hills just west of the Superior-Cronese Conservation Area. Campbell (1983) attributed 97% of juvenile tortoise shells at the base of fence posts along a 30.5-mile stretch of fencing to raven predation. Berry et al. (1986) reported ravens as being responsible for 3% to 31.8% of mortality among desert tortoises on the Fremont Peak (3%, two individuals), Kramer Hills (31.8%, seven individuals), Chemehuevi Wash (11%, two individuals) and Chuckwalla Bench (25.5%, 13 individuals) PSPs. Woodman and Juarez (1988) determined that ravens accounted for 97% of juvenile tortoise deaths near Kramer, California. Recently, ravens have been observed attacking and injuring adult tortoises on the Fort Irwin translocation plots (Danna Hinderle, personal communication, June 2009).

Subsidized raven populations can affect desert tortoises through both "spillover predation," where predators hunt in adjacent underdeveloped areas away from a large and sustained flock, and "hyperpredation," which refers to predator populations maintained by a diverse prey base despite a declining population of a single prey species (Kristan and Boarman 2003).

The predation of juvenile tortoises by common ravens is thought to be higher in the western Mojave Desert than elsewhere in the Mojave, primarily because of the higher number of roads, landfills, agricultural developments, fences, and transmission poles (Berry 1985). The long-term implications of elevated predation of desert tortoises by common ravens are not completely understood. The targeted predation of juvenile tortoises will likely lead to an altered age-class structure, and a significant decrease in recruitment of juvenile tortoises (Berry 1985; Boarman 1993, 2002b, 2003).

Cumulative and Interactive Effects with other Threats

As previously discussed, urbanized areas, roads, and landfills provide food and water sources for ravens and other subsidized predators, while transmission towers, utility poles, and other structures provide nesting and perching habitat for ravens. Significant differences in raven numbers have been documented along transmission lines and highways versus secondary roads and areas away from linear rights-of-way (Boarman 1993). In a study of existing data, Boarman and Coe (2000) found that ravens were far less common in areas away from roads. McCullough Ecological Systems (1995) identified locations

underneath transmission towers as sites where juvenile tortoise remains subjected to raven predation were common. Boarman (2002b) also found that ravens were significantly more abundant in agricultural areas than nearby rangeland and open desert areas of the Mojave Desert. Though not documented, other human developments and activities probably contribute to subsidizing predators, including camps associated with OHV users and military personnel, litter and illegal dumping, active mines, water sources associated with livestock grazing, and construction sites associated with human developments. The intensity of predation by subsidized predators places added pressure on desert tortoise populations during periods of drought.

Distribution within Conservation Areas

Raven nests and feral dog sightings have been documented within the Superior-Cronese Conservation Area, specifically along the Interstate 15 corridor and in areas closer to Barstow, California (Figure D-40 in Appendix D). Six electric transmission corridors run through the southern portion of the Superior-Cronese Conservation Area, which provide vertical structure that supports the majority of raven nests in the area. Landfills and linear features, such as roads and transmission lines, are especially abundant in this portion of the Superior-Cronese Conservation Area. In a spatial analysis study of desert tortoise threats, Heaton (2007) reported moderate presence of ravens within the southwest portion of the Superior-Cronese Conservation Area, along the sampled stretches of Interstate 15 and Interstate 40. At a study of the Fort Irwin relocation sites within the Superior-Cronese Conservation Area, raven densities were found to be highest in three different areas, all of which were anthropogenic linear corridors: Interstate 15, a transmission right-of-way, and Manix Road, which leads into Fort Irwin (McIntyre et al. 2007).

In a spatial analysis study of desert tortoise threats, Heaton (2007) reported moderate presence of ravens within the southern portion of the Gold Butte-Pakoon Conservation Area. We detected several desert tortoise predators on study plots sampled in the Gold Butte-Pakoon Conservation Area. Ravens were observed in low numbers within each of the treatment areas (Table 6). Evidence of coyotes (dens, digs, tracks, and scat) was much more common in the Urban and Control Treatment Areas compared to other treatment areas (Table 5). Domestic dogs were only observed in the Urban Treatment Area (Table 5).

We predicted occurrence areas for predator populations subsidized by anthropogenic food and water sources within each of the Conservation Areas by placing buffers around features that provide subsidies for ravens, coyotes, and other subsidized predators. These included urbanized areas, landfills, open sources of anthropogenic water, major highways, agricultural fields, and transmission lines (Figures E-10 and E-27 in Appendix E).

Invasive Plants

Non-native, invasive plant species probably first arrived in the Mojave Desert with settlers during the late 1800s and early 1900s (Jennings 1997b). Livestock grazing over the following century provided the opportunity for widespread expansion of non-native plants throughout the region. The Mojave Desert generally exhibits a low proportion of non-native flora species; however, the percentage of biomass due to non-natives is extremely high (Brooks and Berry 1999, 2006). Importantly, although the diversity of non-native species is low (approximately 9% as of the end of the 1970s [Rowlands et al. 1982]), the extent and abundance of the few non-native species present have greatly reduced both the abundance and diversity of native species. The main non-native species of concern within the Mojave Desert region include: 1) split grass, also known as Mediterranean and Arabian grass; 2) cheatgrass, 3) red brome; 4) red-stemmed filaree; and 5) Sahara mustard, also known as Asian mustard (*Brassica tournefortii*) (California Invasive Plant Inventory Database 2010). The spread of these invasive plant species degrades otherwise suitable desert tortoise habitat through changing the character of desert scrub vegetation communities, replacing native forage species, and altering the cycles, frequency, and intensity of wildfires. Invasive plant species are less palatable and nutritious than native forage species, and some have been linked to injury or

mortality of desert tortoises (Berry 1998; Boarman 2002a). Finally, invasive plant species may harbor toxins, such as heavy metals, that could potentially poison tortoises if ingested (Jennings 1997b). The Desert Tortoise Oversight Management Group ranked invasive plants and fire second only to disease as major threats to the desert tortoise in 2000 (Brooks and Esque 2002).

<u>Impacts</u>

Mortality

Boarman (2002a) reports that the awns of red brome have been "reported" stuck in the nares of tortoises, and also reported these awns impacting food in the upper jaws of the tortoises; however, no references were cited for these reports. Berry (1998) reports an awn (likely *Bromus* sp.) was found penetrating the gut of an ill tortoise during a necropsy; however, she also notes the difficulty with determining if this threat lowers survivorship in the species.

When nutritional, native forbs are replaced by invasive plants, tortoises may turn to eating the lower quality invasive species potentially resulting in nutrient deficiencies (specifically nitrogen and phosphorus) (Avery 1998; Jennings 1997b); however, Boarman (2002a) considered this concern speculative. Invasive plants do reduce the diversity of native annual plants that tortoises rely on for nutritional balance (Jennings 1997b), and consumption of invasive species over native plants may decrease the amount of water availability for tortoises. Coombs (1979) showed that a shift in diet to invasive annual grasses in the absence of native perennial grasses resulted in tortoises eating senesced and dried plant material by summer and fall months instead of perennial grasses that retain higher water content.

Desert tortoises have evolved to consume native plants and rely on them for sufficient nutrients and water. Although desert tortoise are known to occasionally forage on split grass and filaree, they typically avoid cheatgrass and Saharan mustard (Berry 1998), but red brome was shown to be consumed by tortoises at Rock Valley, Nevada (Nagy and Medica 1986). The proportion of invasive plants in the diet of desert tortoises appears to vary according to local conditions. Berry (1998) determined that the tortoise's diet at a PSP at the Desert Tortoise Research Natural Area was composed of only 4.65% invasive species (3.93% filaree, 0.69% *Schismus* spp., and 0.03% *Bromus* spp.). In contrast, Coombs' (1979) analysis of the food habits of desert tortoise on the Beaver Dam Slope found that two invasive annuals (red brome and filaree) were dominant portions of their diet. In other areas of the Mojave tortoises forage on these two non-native species only in the absence of preferred native species (Berry 1974). It is likely that red brome and filaree currently make up a substantial portion of Beaver Dam slope tortoise diets because of the decreased availability of perennial grasses in this area resulting from livestock grazing. Avery (1998) found that desert tortoise preferred invasive split grass over the three other species offered (*Camissonia boothii*, an annual forb; *Mirabilis bigelovii*, an herbaceous perennial shrub; and the invasive filaree), even though it was not as nutritionally beneficial. However, split grass has been shown to deplete nitrogen, phosphorus and water, and cause weight loss in tortoises (Avery 1998; Nagy et al. 1998; Hazard et al. 2001). Avery (1998) also observed that distances traveled by desert tortoises was significantly greater on grazed plots than in protected plots, and that the diets of tortoises foraging on protected plots were significantly different and nutritionally superior to those foraging on grazed plots containing higher abundances of non-native species.

Habitat Degradation

In the Mojave and Colorado Deserts, invasive plants have come to comprise a small portion of the flora but a large portion of the biomass. In one study, invasive plants comprised 6% to 27% of the Mojave Desert flora and 66% to 91% of the biomass, depending on annual rainfall (Brooks and Berry 2006).

Changes to native vegetation communities including reduced biomass and diversity of native species results from competition with non-native annual species, and have a significant impact on desert tortoise populations because native annuals can comprise as much as 95% of their diet (Jennings 1993, 2002; Oftedal et al. 2002)

Research has documented how invasive plant species out-compete native plant species, changing the composition and availability of forage plants preferred by the desert tortoise (Brooks 1999b, 2000; Brooks and Berry 1999). Non-natives compete with native species via several pathways including water uptake, timing of germination, and nitrogen use. Some invasive grasses, including red brome, cheatgrass, and Mediterranean grasses, out-compete native species for water (Brooks and Pyke 2001). Mediterranean grass are more successful at water uptake because of a filamentous root structure that spreads easily through the soil and more effectively absorbs water than the typical tap root root systems of native species (Boarman 2002a). Certain invasive species (*Bromus* spp., *Schismus* spp., and filaree) germinate earlier and their established seedlings can inhibit the growth of native seedlings (Brooks and Esque 2002). Established red brome, Mediterranean grass, and filaree more effectively use nitrogen in soils causing reduced native seedling biomass and inhibiting seed germination (Brooks and Pyke 2001). In addition, the accumulation of plant litter from invasive species can impede germination of native plants by shading the soil, reducing water infiltration, and preventing the seeds of native plants from reaching the soil (Brooks 2000; Brooks and Berry 1999; Brooks and Esque 2002).

<u>Cumulative and Interactive Effects with other Threats</u>

Fire

Invasive species have altered the fire cycle, increasing both the frequency and intensity of wildfires in the desert environment (Brooks et al. 2006). The large biomass produced by invasive plants increases fuel loads that facilitate hot fires in a desert ecosystem that did not evolve to withstand frequent and intense fires (Berry 1998; Brooks and Berry 2006). The introduction of more frequent and intense fires has further contributed to the conversion of desert scrub communities into non-native communities (Brooks and Esque 2002). In addition, invasive grasses thrive in post-fire landscapes, partially due to increased nutrients in the soil; this leads to recurrent fires (Brooks and Pyke 2001; Brooks and Esque 2002) and further degradation of natural desert conditions.

Other Cumulative and Interactive Threats

The spread of invasive species in the Mojave Desert is facilitated by paved and dirt roads, including those that access utilities, landfills, and mines; human developments and urbanization; anthropogenic water sources; and disturbances caused by human activities, such as mining, recreation (i.e., OHV use), agricultural activities, military activities, and livestock grazing. Biomass of invasive plants increases in areas affected by nitrogen deposition from poor air quality. Invasive plants typically uptake toxins and pollutants, which may accumulate in the tissues of desert tortoises, making them more susceptible to disease.

<u>Distribution within Conservation Areas</u>

Occurrences of three invasive plant species (*Schismus* spp., *Bromus* spp., and *Brassica tournefortii*) were documented during the 2005 LDS transect surveys to include in the spatial inventory of perceived threats to desert tortoise (Heaton 2007). *Bromus* spp. was found throughout the Gold Butte-Pakoon Conservation Area and within the western portion of the Superior-Cronese Conservation Area. *Schismus* spp. was found throughout both areas. *Brassica tournefortii* occurrence was low for both areas and was associated with dirt and paved roads. Surveys conducted within the Gold Butte-Pakoon Conservation Area by NPS

between 2004 and 2008 (NPS unpublished data), documented invasive plants along road transects. Within the limited survey area, 12 species of invasive plants were documented, including Sahara mustard, cheatgrass, tocalote (*Centaurea melitensis*), farmer's foxtail (*Hordeum murinum*), rabbitfoot grass (*Polypogon monspeliensis*), and Russian thistle (*Salsola tragus*).

We recorded the presence and relative abundance of invasive plant species known to negatively impact desert tortoises and their habitat on study plots in the Gold Butte-Pakoon Conservation Area. Red brome, Mediterranean grass, and erodium were fairly common within each treatment area, whereas the diversity of invasive plant species was greater in the Fire and Grazing Treatment Areas (Table 6). Based upon our findings, we estimate that invasive plants occur over all of the Conservation Area.

Without detailed data from the Superior-Cronese Conservation Area, we assume that the entire Conservation Area is affected by invasive plants.

3.3.4 Threats Ranking

We examined the importance of threats within each Conservation Area according to the effects they produce (whether they cause mortality in desert tortoises, whether they contribute to habitat loss, degradation, or fragmentation, whether they facilitate human access into desert areas supporting desert tortoise); how they contribute to or otherwise interact with other threats; how severe the threats are in terms of their spatial distribution or probability of occurrence within each of the Conservation Areas; how the most serious threats occur or may occur in the future on land in-holdings within each of the Conservation Areas; and how the distribution or severity of the threat has changed between 1990 and 2008. The following discussion details how each threat was ranked according to their effects, interactions, and distributions within the Conservation Areas.

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access and Threat Interactions

Table 11 details the score of each threat among the effects they produce (mortality of desert tortoises; habitat loss, fragmentation, or degradation; and facilitation of human access to desert environments), and the manner in which threats contribute or interact with each other. A detailed rationale for the scoring of these threats is provided in Appendix E.

Table 11. Threat Scores among the Various Effects (Mortality [M_t], Habitat Loss, Fragmentation, or Degradation [H_t], and Facilitation of Human Access to Desert Areas [A_t]) of Threats within the Conservation Areas

	Mortality (M_t)	Habitat Loss, Fragmentation or Degradation (H_t)	Human Access to Desert Environments (A_t)	Interactive (I_t)
Human Developments				
Urbanization	3	3	3	3
Roads	3	3	3	4
Railroads	2	3	0	1
Utilities	2	3	3	2
Landfills	1	2	2	2
Anthropogenic Water	0	3	0	2

Table 11. Threat Scores among the Various Effects (Mortality [M_t], Habitat Loss, Fragmentation, or Degradation [H_t], and Facilitation of Human Access to Desert Areas [A_t]) of Threats within the Conservation Areas

	Mortality (M_t)	Habitat Loss, Fragmentation or Degradation (H_t)	Human Access to Desert Environments (A_t)	Interactive (I_t)
Sources				
Human Actions and Activities				
OHV	1	3	3	3
Livestock Grazing	1	2	0	1
Agricultural Practices	1	3	0	1
Mineral Extraction	2	2	2	2
Military Activities	3	2	2	3
Litter and Illegal Dumping	1	1	0	2
Toxin and Pollutant Deposition	2	2	0	3
Degradation of Air Quality	1	2	0	3
Climate Change	3	3	0	1
Collection and Poaching by Humans	3	1	0	2
Translocation of Tortoise Populations	3	0	0	2
Environmental/Biological Factors				
Drought	3	0	0	1
Fire	3	3	0	2
Disease	3	0	0	2
Subsidized Predators	3	0	0	3
Invasive Plants	0	1	0	3

Distribution/Severity of Threats within the Conservation Areas

The variables of distribution/severity (d) of each threat within the Conservation Areas are presented in Table 12. These were determined by assessing the severity of each threat within the Conservation Areas based upon the threats literature review, historical knowledge of each threat's specific effects within the Conservation Areas, and the spatial distribution of each threat. We provide rationale for assignment of the distribution/severity variables for each threat in Appendix E.

Table 12. Threat Severity Variables (d) Based Upon the Distribution/Probability of Occurrence of Each Threat within the Gold Butte-Pakoon and Superior-Cronese Conservation Areas

	Gold Butte-Pakoon (d)	Superior-Cronese (d)
Human Developments		
Urbanization	0.00016	0.3235
Roads	18.54	25.89
Railroads	0.00	3.94
Utilities	0.0052	0.81
Landfills	0.00	0.00018
Anthropogenic Water Sources	0.000044	0.00132
Human Actions and Activities		
OHV Use	5.60	11.31
Livestock Grazing	100.00	0.00
Agricultural Practices	0.000425	0.118
Mineral Extraction	0.11	0.33
Military Activities	0.00	1.28
Litter and Illegal Dumping	0.258	1.736
Toxins and Pollutant Deposition	0.40	2.69
Degradation of Air Quality	1.70	6.28
Climate Change	20.5	36.16
Collection and Poaching by Humans	6.23	20.96
Translocation of Tortoise Populations	0.00	29.2
Environmental/Biological Factors		
Drought	0.00	32.25
Fire	34.21	0.061
Disease	2.16	12.25
Subsidized Predators	25.32	40.82
Invasive Plants	100.00	100.00

Severity of Selected Threats on Land In-holdings

The maximum potential ($\hat{I}_{max}$) severity of selected threats (urbanization, mining, agriculture, and military activities) within land in-holdings in each the Conservation Areas are presented in Table 13. We determined these values by assessing the maximum potential spatial distribution on appropriate landforms within the in-holdings. The $\hat{I}_{max}$ values were expressed as the percent area occupied (or projected to be occupied) by these threats, divided by the total area of each respective Conservation Area. We provide rationale for assignment of the in-holding variables for each threat in Appendix E.

Table 13. Projected Maximum ($\hat{I}_{max}$) Severity of Selected Threats on Land In-holdings within the Gold Butte-Pakoon and Superior-Cronese Conservation Areas

	Projected Maximum Acreage	Projected Maximum Percent Area ($\hat{I}_{max}$)
Gold Butte-Pakoon		
Urbanization	1,277	0.21
Mines	1,568	0.26
Agriculture	1,149	0.19
Military Activities	0	0.00
Superior-Cronese		
Urbanization	131,370	20.86
Mines	52,841	8.39
Agriculture	130,623	20.74
Military Activities	9,350	1.48

Degree of Change of Threats within Conservation Areas

The degree of change (C_t) of selected threats (urbanization, roads, railroads, utilities, landfills, anthropogenic water sources, OHV use, livestock grazing, agricultural practices, mineral extraction, and fire) within each the Conservation Areas are presented in Table 14. We determined these values by examining the change in area attributed to the threat between 1990 and 2008 using remote sensing. The C_t values were expressed as the acres of change detected between 2001 and 2008 divided by the acres of change detected between 1990 and 2001 multiplied by the percent area of change (total) detected within the Conservation Area. We provide rationale for assignment of the degree of change variables for each threat in Appendix E.

Table 14. Degree of Change (C_t) of Selected Threats within the Gold Butte-Pakoon and Superior-Cronese Conservation Areas

	Gold Butte-Pakoon (C_t)	Superior-Cronese (C_t)
Human Developments		
Urbanization	0.00	0.00025
Roads	0.00	0.944
Railroads	N/A	0.00
Utilities	0.00	0.0044

Table 14. Degree of Change (C_t) of Selected Threats within the Gold Butte-Pakoon and Superior-Cronese Conservation Areas

	Gold Butte-Pakoon (C_t)	Superior-Cronese (C_t)
Landfills	N/A	0.00024
Anthropogenic Water Sources	0.00	0.00
Human Actions and Activities		
OHV Use	0.00043	0.296
Livestock Grazing	0.00173	0.438
Agricultural Practices	0.00	0.00
Mineral Extraction	0.00	0.0024
Environmental/Biological Factors		
Fire	0.0329	0.00

Threats Ranking for each Conservation Area

Gold Butte-Pakoon Threats Ranking

The adjusted score (S_A) of each threat, as well as the ranking of threats within the Gold Butte-Pakoon Conservation Area is presented in Table 15.

Table 15. Adjusted Scores and Ranking of Threats within the Gold Butte-Pakoon Conservation Area

	Adjusted Score (S_A)	Rank
Livestock Grazing	8.01384	1
Fire	6.375	2
Invasive Plants	5.0	3
Roads	4.0788	4
Climate Change	3.28	5
Subsidized Predators	3.0384	6
OHV Use	0.84645	7
Collection and Poaching by Humans	0.8099	8
Disease	0.2376	9
Mineral Extraction	0.1988	10
Degradation of Air Quality	0.17	11
Urbanization	0.0924336	12
Toxin and Pollutant Deposition	0.052	13
Agricultural Practices	0.0430425	14
Litter and Illegal Dumping	0.01806	15

Table 15. Adjusted Scores and Ranking of Threats within the Gold Butte-Pakoon Conservation Area

	Adjusted Score (S_A)	Rank
Utilities	0.000884	16
Anthropogenic Water Sources	0.00000352	17
Railroads	0.00	18
Landfills	0.00	18
Military Activities	0.00	18
Translocation of Tortoise Populations	0.00	18
Drought	0.00	18

Superior-Cronese Threats Ranking

The adjusted score (S_A) of each threat, as well as the ranking of threats within the Superior-Cronese Conservation Area is presented in Table 16.

Table 16. Adjusted Scores and Ranking of Threats within the Superior-Cronese Conservation Area

	Adjusted Score (S_A)	Rank
Roads	590.348	1
Climate Change	578.56	2
Invasive Plants	500	3
Subsidized Predators	489.84	4
Urbanization	437.92875	5
Drought	322.5	6
Collection and Poaching by Humans	272.48	7
Translocation of Tortoise Populations	233.6	8
Agricultural Practices	207.48	9
OHV Use	174.09	10
Disease	134.75	11
Mineral Extraction	122.1136	12
Degradation of Air Quality	62.8	13
Railroads	51.22	14
Toxin and Pollutant Deposition	34.97	15
Military Activities	23.04	16
Utilities	13.8448	17
Litter and Illegal Dumping	12.152	18
Livestock Grazing	3.054	19
Fire	1.04431	20
Anthropogenic Water Sources	0.01056	21
Landfills	0.00462	22

3.4 BLM Management Plan Review

The following discussion summarizes land management plans that have been developed for and implemented on BLM lands within each of the Conservation Areas between 1994 and 2008. This section also includes other plans or laws that the BLM participates in or is subject to. Some of the plans were developed prior to 1994 but were in effect until 1994 or later. In reviewing each plan, we provide information pertaining specifically to management of the desert tortoise and threats that affect desert tortoise and/or their habitat. We review the historical implementation of the measures included in the plans. Finally, we assess the level of law enforcement that has been applied in each of the Conservation Areas to enforce laws and policies contained within the land management plans.

3.4.1 Range-wide Plans

Desert Tortoise Habitat Management on the Public Lands: A Rangewide plan (1988)

Plan Details

The Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan (DTHMPL) was developed by the BLM after recognizing that desert tortoise populations were declining throughout their range. The intent of the plan was to prevent the listing of the species under the ESA. The plan was developed to manage tortoise habitats using an ecosystem management approach with emphasis on maintaining or restoring natural biological diversity. This was accomplished by assigning categories (Categories I-III, with I being the highest quality) to the habitat areas on BLM lands within the range of the desert tortoise based upon habitat quality and species abundance. The management strategies within the DTHMPL were primarily focused on limiting threats that affected tortoise habitat designated as Category I and Category II. Goals for Category I habitat areas included maintaining stable, viable populations and protecting existing tortoise habitat, while increasing populations where possible. Goals for Category II habitat areas included maintaining stable, viable populations and halting further declines in tortoise habitat value.

In order to achieve the goals for the Categories, fourteen management objectives (MO) were established and management actions (MA) were enacted to ensure that the objectives were reached. The MOs and MAs that pertained to desert tortoise management included:

- MO 8 sought to reduce the effects of granting rights-of-way (ROWs) through Category I and II habitat areas. MA 8C stipulated that allowance would only be given to new ROWs if no reasonable alternative existed and if sufficient mitigation was offered to minimize the effects of desert tortoise habitat loss due to construction.
- MO 9 sought to ensure that OHV use in desert tortoise habitats was consistent with the Category goals.
- MAs 9A and 9C allowed the closure of portions and the reduction (restricted to designated road and trails) of OHV use in other portions of Category I and II habitat areas. MA 9C also recommended the placement of limits on commercial and competitive OHV events.
- MO 10 sought to minimize the threats to desert tortoise from grazing attributed to livestock and feral horses and burros in Category I and II habitat areas. Limits to grazing were sought to allow for the availability of sufficient native forage throughout the year for desert tortoise use (MAs 10A, 10B, 10C, and 11C). MAs 10D and 11D stipulated that allowances be made for new range improvements for livestock feral horses and burros only if they did not create conflicts with

tortoise populations and were properly mitigated, while recommending that conflicting existing improvements be eliminated.

- MO 13 addressed predation on tortoises on a broad scale and primarily advocated further study of how predators affected tortoise populations (MA 13A) and how human activities promoted the prevalence of predators (MA 13B).
- MO 14 addresses the management of the BLM's energy and mineral programs, including the withdrawal of mineral entries from Category I habitat areas (MA 14A). MAs 14B and 14D recommended that impacts to desert tortoise habitat due to energy and mineral development be mitigated to the extent possible through the implementation of BLM's surface management regulations and other existing laws.

Implementation Success

The DTHMPL became outdated when the 1994 Recovery Plan was issued and the BLM Interim Livestock Grazing Program was approved in 1994, though the BLM's habitat category designations were useful in developing measures post-1994 (see below).

Wilderness Act (1964)

Plan Details

The Wilderness Act was enacted to establish the National Wilderness Preservation System that was to be composed of federally owned areas designated by Congress as "wilderness areas." These areas would retain their primeval character and influence, without permanent improvements or human habitation. Commercial enterprises, permanent roads, temporary roads, motor vehicles, motorized equipment, and structures or installations are not allowed within designated wilderness areas. Special provisions were given to existing mineral leases and claims, water resources, and livestock grazing. While not directly addressing desert tortoises, the Wilderness Act and National Wilderness Preservation System established over a million acres of wilderness areas that support desert tortoise populations.

Implementation Success

Four Wilderness Areas were established in the Gold-Butte-Pakoon Conservation Area, including the Lime Canyon and Jumbo Springs Wilderness Areas, and portions of the Paiute and Grand Wash Cliffs Wilderness Areas, accounting for 35,285 acres of designated Critical Habitat within the Conservation Area. Two Wilderness Areas were established in the Superior-Cronese Conservation Area, including the Black Mountain and Grass Valley Wilderness Areas, accounting for 53,776 acres of designated Critical Habitat within the Conservation Area. These areas are off-limits for OHV use and motorized vehicular travel, but may be subject to livestock grazing (see below for a history of grazing management within the allotments).

Interim Livestock Grazing Program (1994)

Program Details

Following the USFWS listing of the desert tortoise under the ESA in 1990 and proposal to designate Critical Habitat is 1993, the BLM initiated a number of Section 7 consultations with the USFWS in support of modifying grazing prescriptions for allotments occupied by tortoises and within desert tortoise Critical Habitat (USFWS 1991a; 1992b; 1993), culminating in the BLM's proposal for an Interim Livestock Grazing Program (USFWS 1994c), which prescribed grazing on BLM-managed lands across

the range of the desert tortoise. The 1994 Recovery Plan recommended that grazing be removed from designated Critical Habitat; the Interim Livestock Grazing Program was proposed to continue grazing in Critical Habitat until the effects of livestock grazing on desert tortoises and their habitat could be assessed. The agencies (USFWS, BLM) focused their measures on proposing and prescribing grazing and fencing actions designed to eliminate competition for forage between livestock and desert tortoises. The Bureau proposed continued licensing of grazing allotments in designated Critical Habitat for an interim period of 2.5 years. Within the Gold Butte-Pakoon Critical Habitat Unit, eleven grazing allotments occupying 379,471 acres were affected by the Interim Livestock Grazing Program (Table 17). The program affected three grazing allotments occupying 104,070 acres in the Superior-Cronese Critical Habitat Unit (Table 18). The USFWS issued a Biological Opinion that included area specific measures for continued grazing in Critical Habitat (discussed below). In Categories I, II, and intensive III desert tortoise habitat areas were assigned Prescription 1, which measures included prohibition of grazing from March 1 to June 14, and utilization limits between June 15 and February 28 that were not to exceed 50 percent on key perennial grasses and 45 percent on key shrubs.

Table 17. Recommended grazing prescriptions for allotments within the Gold Butte-Pakoon Critical Habitat Unit, per the approved Interim Livestock Grazing Program (USFWS 1994c)

Name	State	Acres in CH	Grazing Treatment
Billy Goat Peak	NV	32,606	Cattle: Prescription 1
Gold Butte	NV	56,756	No Grazing
Hen Springs	NV	16,314	Cattle: Prescription 1
Littlefield	AZ	32,255	Cattle: Summer/Fall/Winter
Mesquite Community	AZ/NV	16,148	Cattle: Year-round Rotation
Pakoon	AZ	54,244	Cattle: Fall/Winter
Pakoon Springs	AZ	37,199	Cattle and Horses: Summer/Fall/Winter
Mosby-Nay	AZ	26,109	Cattle and Horses: Summer/Fall/Winter
Tassi	AZ/NV	83,400	Cattle and Horses: Summer/Fall/Winter
Mudd & Cane	AZ	10,784	Cattle: Year-round Rotation
Cottonwood	AZ	13,656	Cattle: Year-round Rotation

Table 18. Recommended grazing prescriptions for allotments within the Superior-Cronese Critical Habitat Unit, per the approved Interim Livestock Grazing Program (USFWS 1994c)

Name	Acres in CH	Grazing Treatment
Cronese Lake	38,650	Cattle: Year-long
Pilot Knob	48,280	Cattle: Rest Rotation
Harper Lake	17,140	Cattle: Year-long

Arizona

In several Biological Opinions (USFWS 1994c; 1995; 1997a), the USFWS allowed extensions of grazing in designated Critical Habitat in Arizona under terms and conditions that included: 1) implementation of a public awareness program that informs the public of the status of the desert tortoise and its protections under the ESA; 2) implementation of a training program for BLM staff and grazing permittees designed to reduce grazing-related take of tortoises; 3) implementation of a monitoring program designed to track compliance with the Biological Opinion; 4) removal of livestock from Category I and II desert tortoise

habitat areas between March 15 and June 1; and 5) conduct desert tortoise surveys prior to the construction and maintenance of fences. Other measures included: 1) removal of livestock from categorized desert tortoise habitat when average utilization levels for certain plant species exceeded 45%; 2) discontinue the use of roughage for supplemental feeding of livestock; 3) use of motorized vehicles only on existing roads and trails; and 4) no range improvements that created conflicts with desert tortoise would be allowed (USFWS 1994c).

Nevada

For allotments in Nevada, the USFWS allowed grazing under the following terms and conditions: 1) the BLM would implement grazing Prescription 1 as a full force and effect decision; 2) motorized vehicles would be restricted to existing roads and trails; 3) trash would be removed from camp sites associated with grazing operations; 4) sheep carcasses within 300 feet of any road would be disposed; 5) the BLM would implement evaluations, agreements, decisions, and/or Allotment Management Plans for all active grazing allotments over a period of five years; 6) sheep bedding sites would be limited to one used per day; 7) sheep campsites would be limited to one used per week; 8) sheep would be watered immediately adjacent to unpaved roads; 9) use of hay is prohibited; 10) grazing Prescription 1 would be applied to all allotments that contain Categories I, II, and/or intensive tortoise habitat; 11) no grazing in Categories I, II, and/or intensive III tortoise habitat unless spring ephemeral forage in the allotment was above 150 pounds of air dry forage per acre; 12) sheep bands would be no greater than 1,000 adult sheep and approximately the same number of lambs; 13) sheep grazing would be limited to one pass per location; 14) the BLM would appoint a contact representative responsible for compliance with the terms and conditions and coordinating with the USFWS; 15) the BLM would administer an education program to all allotees and lessees to inform them of the occurrence and status of desert tortoises within the allotments; 16) the BLM would inspect grazed areas with aerial or vehicular reconnaissance to ensure compliance; 17) the BLM would establish monitoring sites near watering sites to ensure that utilization levels are in compliance; 18) utilization levels would not exceed 40% of key perennial species between June 15 and October 15, and 50% utilization of key perennial grasses and 40% of key perennial shrubs and forbs between October 15 and February 28; 19) the BLM would establish a minimum of eight additional permanent desert tortoise monitoring plots in Categories I, II, or intensive III desert tortoise habitats to monitor demographic trends; and 20) sheep herders would be required to carry a copy of the current use authorization (USFWS 1994c).

California

For those allotments in the Superior-Cronese Critical Habitat Unit, the USFWS allowed grazing under the following terms and conditions: 1) in key areas, utilization would be limited to 30 to 50% per the California Desert Conservation Area (CDCA) Plan, and in desert tortoise habitat utilization of key perennial grasses would not exceed 40% between February 15 and October 14; 2) supplemental feeding of roughage to livestock would be prohibited in desert tortoise habitat; 3) range improvements would be situated in previously disturbed sites whenever possible, and would be subject to environmental review; 4) grazing would be curtailed during periods of drought; 5) the BLM would ensure that all proposed range improvement projects be planned and implemented to reduce environmental impacts; 6) fences would be carefully positioned to avoid impacts to desert tortoises and their burrows; 7) pipelines would be installed in previously disturbed areas or adjacent to existing pipelines; 8) the lessee would notify the BLM when using mechanical equipment in off-road situations so that the BLM can implement measures 3 and 5; 9) cattle should be grazed in a scattered formation in use areas, rather than in herds; 10) the BLM would monitor perennial plant utilization, ephemeral forage production, and range condition according to Allotment Management Plans (AMP) and the California Desert Conservation Area Plan; 11) grazing use may exceed perennial forage authorizations through issuance of temporary (1-month) agreements in categories I and II desert tortoise habitat and 3-month agreements in Category III habitat; 12) all allotments would be managed per AMPs, and AMPs would be completed by July 13, 1995; 13)

authorization for foraging in Category III habitat would be granted only when ephemeral forage exceeds 200 pounds or more per acre; 14) the BLM would manage allotments in a manner that increased the abundance and diversity of native perennial and annual plants; 15) the BLM would participate in research into the nutrition, health, and epidemiology of tortoises, and the effects of grazing of desert tortoise habitat, and develop livestock management practices based upon the results of the studies; 16) crews or personnel that implement actions under the Biological Opinion would receive desert tortoise awareness training; 17) a suite of mitigation and avoidance measures would be implemented on construction projects, including seasonal restrictions, pre-construction surveys, and biological monitoring of active construction projects by authorized personnel; 18) cattle carcasses found within 300 feet of a road would be removed; 19) the BLM would provide an annual report to the USFWS detailing implementation of the Biological Opinion; 20) utilization of key species in fair and poor allotments would not exceed 30%; 21) utilization of key species in allotments with cattle distribution problems would not exceed 40%; 22) ephemeral forage would be authorized only when ephemeral production exceeds 350 pounds per acre; 23) no new watering features would be authorized; 24) new range improvements would only be allowed if they do not create conflicts with desert tortoise populations; 25) temporary, non-renewable uses would not be authorized except in allotments determined to be in good range condition or better; 26) utilization of key species would not exceed 40% in Group 2 and 3 allotments; 27) new key areas would be established near water in Category I and II desert tortoise habitats; 28) the Cronese Lake allotment would be authorized for temporary, non-renewable use only; 29) construction of a water development in the Cronese Lake allotment would proceed; 30) a two-pasture rotational grazing system would be implemented in the Harper Lake allotment; and 31) a five-pasture, deferred rotation grazing system would be implemented in the Pilot Knob allotment (USFWS 1994c). The Biological Opinion (USFWS 1994c) was extended with modifications (USFWS 1999; 2000a), with the expectation that revised grazing prescriptions would appear in the soon-to-be-released West Mojave Plan.

In California, the BLM also initiated a series of Section 7 consultations with the USFWS (USFWS 1991b; 1992c) in support of establishing rules for authorizing ephemeral sheep grazing allotments within Category I-III habitats on BLM-managed lands in the western Mojave and northern Colorado Deserts. Following a successful lawsuit from the Sierra Club Legal Defense Fund and others to limit grazing allowances in Category I and II habitats, the BLM initiated a Section 7 consultation with the USFWS in support of revised grazing prescriptions that reflected the outcome of the case (USFWS 1994d). The resulting Biological Opinion (USFWS 1994d) described limitations of allotments primarily to Category III habitats, plus the following measures: 1) grazing of Category I and II habitats would not be permitted after March 20 and only in allotments that support at least 350 pounds (air-dry-weight) of ephemeral forage per acre; 2) in Category III habitats, grazing was permitted on allotments that support more than 200 pounds of ephemeral forage per acre; 3) grazing authorizations will be granted on an annual basis, and herders would carry a copy of the current authorization; 4) sheep bands would be limited to 1,000 adults with an approximately equal number of lambs; 5) sheep would be grazed in a loose pattern; 6) grazing use would be limited to one pass per season; 7) bedding and watering sites would be changed daily, and sheep would be watered adjacent to unpaved roads only; 8) stopping, parking, or camping in vehicles would be limited to 50 feet from the edge of designated routes; 9) campsites and trailers would not remain in the same location for more than seven days; 10) sheep would be watered on or directly adjacent (within 25 feet) to unpaved roads, or in previously disturbed areas; and 11) the lessee/permittee would submit a map delineating used areas within the allotment following close of the prescribed grazing period. The Biological Opinion (USFWS 1994d) was extended annually through 1999 (USFWS 1995b; 1996c; 1997b), likely with the expectation that any revised grazing prescriptions would appear in the soon-to-be-released West Mojave Plan.

Implementation Success

No documentation exists that describes whether or not the measures contained in the Biological Opinion (USFWS 1994c) were implemented within the Conservation Areas. However, it is clear that the BLM experienced mixed success in terminating the allotments within Critical Habitat, as recommended in the 1994 Recovery Plan. The efforts to revise grazing authorizations within each state are discussed below.

Arizona

In the 1995 Biological Opinion written for the Arizona Strip District (USFWS 1995a), the USFWS pressed the BLM to provide an amendment to the Arizona Strip District: Resource Management Plan that addressed grazing prescriptions in Critical Habitat that were consistent with the 1994 Recovery Plan. The final extension for grazing in Critical Habitat expired in 1999, and the BLM issued grazing decisions that terminated livestock grazing allotments within Critical Habitat on the Arizona Strip. The permittees appealed, but by 2002 the decisions were final and the allotments were officially terminated. However, due to anti-government sentiment by the ranchers, they continued to graze their livestock in Critical Habitat on the Arizona Strip (Redlands Institute 2002).

Nevada

All grazing allotments within the Nevada portion of the Gold Butte-Pakoon Critical Habitat Unit were retired in 1994. However, illegal grazing of livestock within these areas has been an issue ever since and continues to be an issue today.

California

The grazing practices allowed under the Interim Livestock Grazing Program were extended until 1999 for allotments in California that occurred in Critical Habitat. This allowed the BLM time to complete analyses of the condition of the allotments (USFWS 1999). In the Biological Opinion, the USFWS expected that new grazing measures and prescriptions would be contained in the soon-to-be-released West Mojave Plan.

3.4.2 Gold Butte-Pakoon Conservation Area Plans: Arizona

Arizona Strip District: Resource Management Plan (1992)

Plan Details

The Arizona Strip District: Resource Management Plan (ASDRMP) identifies prescriptions for public lands managed by the BLM on the Arizona Strip District. The district encompasses about 2.8 million acres of public lands in the northwest corner of Arizona. Historic and potential desert tortoise range is included in some 350 square miles of the Arizona Strip, with the majority of this area (85%) consisting of public lands. The ASDRMP includes the following recommendations with respect to managing desert tortoises and their habitat:

- For the majority of the Arizona Strip, unnecessary roads should be closed and rehabilitated
- OHVs should be limited to designated roads and trails. An OHV management plan should be prepared that designates roads to be open, limited or closed.
- Old landfill facilities were recommended for closure, with new facilities located in approved areas.

- Biological evaluations of livestock grazing management activities should be conducted in areas of the Strip that support desert tortoises in order to develop and revise allotment management plans where necessary in order to conform to the requirements of the BLM's DTHMPL.
- Air quality on the Strip should be managed to prevent degradation of Class I federal air quality standards in national parks and to maintain Class II air quality standards and State air quality standards on other public lands.
- Protective requirements during fire management were considered critical to the existence of special-status plant and wildlife species.

In a memorandum dated July 14, 1995, the Arizona Strip District initiated Section 7 consultation with the USFWS on a preliminary plan to implement the 1994 Recovery Plan in the northeastern Mojave Recovery Unit. This culminated in the issuance of the Mojave Amendment to the ASDRMP (BLM 1998). The amendment proposed the designation of the Virgin Slope and Pakoon ACECs, the prescription of grazing for allotments within Critical Habitat, the participation in the development of an interagency desert tortoise population monitoring program, and the elimination of desert tortoise habitat categories, with compensation given to the Pakoon ACEC at the category 1 rate and to the Virgin Slope ACEC at the category 2 rate (USFWS 1998). Specific measures included:

- Allowing mineral exploration and development on a case-by-case basis while ensuring that the cumulative impacts of these activities do not significantly impact tortoise recovery
- Initiating full fire suppression activities within desert tortoise ACECs.
- Not authorizing livestock grazing within the Virgin Slope ACEC from March 15 to October 15 of each year. This includes the tortoise pastures of the Littlefield and Mesquite allotments. Temporary, non-renewable permits would not be authorized in the ACEC.
- Closing the Pakoon ACEC to grazing, and not authorizing domestic livestock grazing within the Pakoon ACEC. This includes all of the Tassi allotment, most of the Mosby-Nay allotment, as well as small portions of the Pakoon and Pakoon Springs allotments.
- Implementing monitoring, research, and improvement projects where livestock grazing is authorized in desert tortoise habitat.
- Complying with the Arizona Standards and Guidelines for Rangeland Health where livestock grazing is authorized in desert tortoise habitat.
- Prohibiting or limiting activities that would result in vegetation removal.
- Acquiring land in-holdings within the ACEC boundaries.
- Closing routes to avoid redundancy (and subsequent habitat degradation) and tortoise mortality, restricting the development of new routes, and designating routes and limited use areas within the ACECs.
- Establishing guidelines that mitigate or eliminate the effects of human recreation on desert tortoises and their habitat.
- Remove burros from the Tassi allotment.

- Managing for other wildlife.
- Enforcing laws and policies with BLM ranger patrols.

Additionally, the BLM would restore disturbed areas, sign and fence the ACECs, implement appropriate administration, provide environmental education, not authorize military activities, cooperate with other agencies to control wild dogs and vandalism, and manage tortoises outside of the ACECs among other related terms and conditions.

<u>Implementation Success</u>

ACECs

The Virgin Slope and Pakoon ACECs were created as a result of the issuance of the Mojave Amendment of the ASDRMP by the BLM. Additional protection was afforded to desert tortoise Critical Habitat in the southern portion of the Pakoon Basin with the designation of the Grand Canyon – Parashant National Monument by President Clinton in 2000. This area is co-managed by the BLM and NPS.

In 2002 the BLM acquired 240 acres of private property at Pakoon Springs within the Pakoon ACEC (Redlands Institute 2002).

Feral Livestock

In 2002 and 2003, the Arizona Strip District removed more than 70 burros from the Tassi Allotment in the Pakoon ACEC (Redlands Institute 2002). The roundups were designed to completely eliminate burros from this allotment, but populations still persist. It is unknown whether additional roundups have been conducted since 2003.

Fire Management

Following take of a desert tortoise during fire suppression activities in the Pakoon Basin in the summer of 1995, the BLM initiated an after-the-fact emergency Section 7 consultation with the USFWS that would allow additional take during fire suppression activities. The BLM proposed to provide a tortoise education program to fire fighters, establish a speed limit for fire-related vehicles, provide monitors, limit off-road activities, inspect under parked vehicles prior to moving them, survey and monitor aircraft landing sites, limit tracked vehicles to road improvements, restrict use of fires as a fire suppression measure where fingers or patches of habitat remain, restore vehicle track to the extent possible, rehabilitate burned areas with seeding and/or planting, monitor vegetation recovery, and evaluation of desert tortoise mitigation measures following a fire. The USFWS recommended reasonable and prudent measures, as well as terms and conditions that expanded upon the measures proposed by the BLM (USFWS 1996a).

In 2005 the BLM again initiated a Section 7 consultation following a series of fires in the late summer of 2005. The Bureau of Land Management (BLM) proposed to stabilize soils in five wildfire areas and initiate vegetative recovery of burned desert tortoise habitat through a variety of treatments, including livestock exclosure fencing, seeding, monitoring, weed management, and conservation measures developed to reduce or avoid impacts to desert tortoises and their habitat. The USFWS recommended reasonable and prudent measures, terms and conditions, and conservation recommendations that expanded upon the measures proposed by the BLM (USFWS 2006b). The BLM reported on their vegetation recovery monitoring efforts in subsequent years (BLM 2008; 2009a; 2009b)

Other Implementations

It is unknown whether other management prescriptions outlined in the Mojave Amendment of the ASDRMP were implemented prior to the development of the subsequent RMP, though several actions with the potential to disturb desert tortoise habitat and/or take tortoises were implemented under the guidelines contained therein and Biological Opinions issued by the USFWS. One such activity includes the expansion of the Pakoon Airstrip within the Pakoon ACEC (USFWS 1996b).

Arizona Strip Resource Management Plan (2008)

Plan Details

The Arizona Strip Resource Management Plan (ASRMP) revises the 1992 ASDRMP and its 1998 Mojave Amendment. This plan was needed following designation of the Grand Canyon-Parashant and Vermilion Cliffs National Monuments by President Clinton in 2000. The monument designations included 245,719 acres of public lands that – up to that point – had been managed by the BLM out of the Arizona Strip Field Office. Following the designations, separate plans were needed that would account for co-management of the monument lands by the BLM and the NPS, and the management of the remaining 1.68 million acres of non-monument lands on the Arizona Strip by the BLM. The plan developed for the monument lands is discussed in the next section. The following discussion applies to the ASRMP that was developed for non-monument lands on the Arizona Strip, specifically those within the Gold Butte-Pakoon Conservation Area.

The ASRMP increased the amount of protected desert tortoise habitat by enlarging the Virgin Slope ACEC by 39,514 acres; however some of these additional lands are located outside of designated Critical Habitat. The plan identifies substantially more threats to desert tortoise than the previous plan, and provides more detailed recommendations to limit the threats. The ASRMP includes species-specific conservation measures that address project-specific mitigation and avoidance measures, and fire suppression and recovery strategies in desert tortoise habitat. The plan outlines a set of 'desired future conditions' (DFCs), and provides a guide for land managers to make decisions for implementing a series of approved management actions. Those that pertain to the management of tortoise populations within the Gold Butte-Pakoon Conservation Area are discussed in detail below.

Urbanization Management

Urbanization of desert tortoise habitat would be limited by the acquisition of non-Federal lands in the desert tortoise ACECs.

Roads Management

Non-essential roads and roads that cause high levels of mortality of desert tortoises will be closed. New paved roadways or modifications of existing paved roads through desert tortoise habitat will be fenced with desert tortoise barrier fencing, with culverts for wildlife passage. Maintenance of roads in desert tortoise habitat will be conducted from October 15 to March 15. Operators of road graders and other maintenance equipment will be required to attend an educational briefing prior to performing the work. Maintenance activities will be limited to previously disturbed areas, unless cleared by a qualified biologist. Vehicles associated with agency-authorized projects traveling on unpaved roads in desert tortoise habitat will be required to keep speeds at or below 40 mph during the tortoise's active season to protect the species. Speed limits may be less on specific roads through high density tortoise areas.

The Arizona portion of the Virgin Slope ACEC is designated primarily as both Specialized and Primitive Travel Management Areas (TMA). Specialized TMAs will be managed to provide for variety of

motorized, non-motorized, and mechanical travel modes to serve existing and future recreational, traditional, casual, commercial, and private needs in remote, rustic settings, but not to the detriment or exclusion of the protection of resources. The Specialized TMA will be managed to serve the day-to-day needs of permit holders, such as ranchers on grazing allotments, and the management needs of local, state, and federal agencies. It will also serve the motorized and non-motorized needs of visitors engaged in activities such as viewing scenery and cultural resources, exploring, camping, hiking, picnicking, hunting, gathering, and studying nature.

Primitive TMAs will be managed to provide for adequate, but limited motorized travel to serve existing and future traditional, casual, some commercial, private, and emergency needs and for non-motorized, non-mechanized travel to serve existing and future recreational needs in the most remote, rustic settings, for the enhancement and protection of important resource values. The Primitive TMAs will be managed for minimal human activities, and to serve the occasional needs of those with permits for the use of resources, such as grazing or research, as well as private, state, and other land ownership needs and a variety of local, state, and Federal agency resource management needs. It will also serve the non-motorized/non-mechanized needs of primarily local, regional, and national visitors engaged in activities such as viewing scenery and cultural resources, backcountry exploring, and hunting. Settings will be managed to allow for few and widely scattered, rustic management facilities in mostly remote, natural-appearing areas where it may be necessary to protect and/or administer important resources.

Major routes accessing the Virgin Slope ACEC and providing connections to routes within Specialized and Primitive TMAs are designated as Backways TMAs. The Backways TMAs will be managed as the primary travel system providing public entry from communities to the more remote and semi-primitive TMAs. The Backways TMAs will allow for interpretive developments and administrative facilities in mostly natural-appearing areas.

Management of Surface-disturbing Actions

Effects to desert tortoise from authorized projects will be minimized or eliminated. To the extent possible, project activities will be scheduled between October 15 and March 15, and project features will be located in previously disturbed areas or outside of desert tortoise habitat. Authorized actions that may result in adverse effects to desert tortoises will require implementation of project stipulations such as worker education programs, pre-construction clearance surveys, defined construction areas, operational restrictions, and procedures for moving tortoises out of harm's way. New ROWs will be routed away from high-density tortoise populations, and routed adjacent or parallel to existing ROWs.

Habitat restoration will be required for activities that result in loss or degradation of tortoise habitat. Habitat will be restored or reclaimed to pre-disturbance condition as practicable. Mitigation measures, such as compensation, may be included in decision documents to offset the loss of quality or quantity of desert tortoise habitat.

OHV Management

OHV use and all other forms of motorized and mechanized travel are limited to designated routes. Competitive speed events will not be authorized in desert tortoise habitat. Organized non-speed events may only occur between October 15 and March 15 in desert tortoise habitat. Organized events with more than 50 participants will require a permit. Organized events are limited to 400 motorcycles or all terrain vehicles, or 300 four-wheeled vehicles. Events will require an appropriate number of compliance monitors to ensure regulations are adhered to. Camping will be restricted to disturbed areas along designated routes.

Grazing Management

Within the Gold Butte-Pakoon Conservation Area, three grazing allotments on the Virgin Slope remain open, including the Littlefield Community and Mesquite allotments, which have seasonal restrictions (October 15 through March 15), and the Mesquite Community allotment, which is available year-round (see Figure D-16 in Appendix D). Grazing utilization levels will be set at 45% of current year's growth on these allotments. Desired plant community objectives will be developed during rangeland health assessments that consider desert tortoise forage, cover, and habitat needs. Desired plant community objectives and recommended actions for achieving these objectives will be incorporated into Allotment Management Plans. Vegetation conditions in desert tortoise habitat will be maintained or improved in accordance with Desired plant community objectives.

Mineral Management

Fluid mineral leasing is open on the Virgin Slope, though surface occupancy is prohibited. Locatable minerals are only allowed on the Virgin Slope with a plan of operation. The Virgin Slope is closed to salable minerals. Special mitigation will be included within mining plans of operation to avoid impacts to desert tortoise.

Fire Management

The BLM will prevent fires in desert tortoise habitat through constructing minimal impact firebreaks. When fire danger is high, fire suppression forces will be pre-positioned in critical areas. Protection of desert tortoise habitat will be prioritized by the quality of the habitat. All wildfires in desert tortoise habitat will be suppressed with minimum surface disturbance, using guidelines provided by Duck et al. (1997). Conservation measures include habitat restoration and rehabilitation following fires in desert tortoise habitat.

Subsidized Predator Management

Construction of new landfills or sewage treatment ponds will not be authorized in the desert tortoise ACECs. Proposed actions will be evaluated to ensure they do not contribute to subsidizing predators within desert tortoise habitat. New water developments may be authorized if they are designed to minimize or eliminate the potential for attracting and subsidizing predators. If predation of tortoises by dogs is documented, the BLM will notify Mohave County to enforce ordinances prohibiting uncontrolled dogs.

Invasive Plant Management

Invasive exotic annual grasses in desert tortoise habitat will be reduced and/or removed.

Population Monitoring

In order to track the success of the management actions, the ASRMP includes a requirement for desert tortoise population monitoring. Specifically, the plan called for monitoring the density and abundance of desert tortoises through a number of techniques, including: 1) documenting numbers of live and dead tortoises (presumably within a survey area); 2) continuing assistance with the Line distance sampling (LDS) surveys conducted by USFWS; 3) conduct random transect surveys throughout the Northeastern Mojave Recovery Unit; and 4) conduct monitoring efforts annually.

Implementation Success

Projects and actions within desert tortoise Critical Habitat within the Pakoon Basin have not yet been implemented, though some may have been under review at the time this report was produced.

Grand Canyon-Parashant National Monument Resource Management Plan (2008)

Plan Details

The Grand Canyon-Parashant National Monument was established on January 11, 2000 to protect an array of scientific, biological, geological, hydrological, cultural, and historical objects. It encompasses 1,048,316 acres in Mohave County, including 245,719 acres of BLM-administered lands within the Arizona Strip. The Grand Canyon-Parashant National Monument Resource Management Plan (NMRMP) contains many of the same provisions and recommendations included in the 2008 ASRMP. It also provides for distinct recommendations for WHAs, ACECs, and ecological zones. Most significantly, the Pakoon ACEC was revoked and re-designated as the Pakoon WHA. The Pakoon WHA has different boundaries than the former Pakoon ACEC and is based on the extent of desert tortoise habitat (surveyed) within the Pakoon Basin. As previously discussed, the designation of this WHA was appropriate because of the protection provided by the National Monument designations for this area, where grazing is prohibited. This re-designation prevented a redundancy in prescriptions. The NMRMP also stipulates that new wilderness management plans for the Paiute and Grand Wash Cliff Wildernesses will be amended or revised to incorporate applicable recovery needs for desert tortoise. The plan is administered by both the BLM and the NPS, who co-manage the area.

The NMRMP includes species-specific conservation measures that address project-specific mitigation and avoidance measures, and fire suppression and recovery strategies in desert tortoise habitat. The plan outlines a set of DFCs, and provides a guide for land managers to make decisions for implementing a series of approved management actions. Many of the management actions that pertain to the management of tortoise populations are identical to those contained in the ASRMP, including the requirement for population monitoring. Those that differ from the ASRMP or are specific to management of desert tortoise populations within the Pakoon Basin of Gold Butte-Pakoon Conservation Area are discussed in detail below.

Grazing Management

The Tassi Allotment will continue to be unavailable for livestock grazing. Those portions of the Mosby-Nay Allotment within the former Pakoon ACEC will be unavailable for grazing. The remaining portions of the Mosby-Nay allotment will be available for grazing. Those portions of the Pakoon Springs Allotment within the former Pakoon ACEC will be unavailable for grazing. In addition, the area unavailable to grazing will be expanded north from the southern allotment boundary up Pakoon Wash approximately 3 miles, and up Cedar Wash and Cottonwood Wash to approximately Wayne's Well. This includes the Pakoon Springs area. Those portions of the Pakoon Allotment within the former Pakoon ACEC (Grand Gulch Wash area) will be available for livestock grazing. Grazing utilization levels will be set at 45% of current year's growth on allotments in desert tortoise habitat.

Wild horses and burros will not be authorized on NPS and BLM-administered lands in the Monument. Burros on NPS-administered lands are managed by prescriptions set by the 1995 Lake Mead NRA Burro Management Plan. The herd management level for the Tassi-Gold Butte Herd Management Area will be set to zero on BLM-administered lands in the Monument. Burros will be removed rather than destroyed on site.

Roads Management

New paved roads will not be authorized in the Pakoon WHA. Temporary upgrading of existing roads and construction of new unpaved roads in the WHA can be authorized only on BLM-administered lands where positive benefits will result for desert tortoise or their habitat. The BLM and/or NPS will maintain or authorize maintenance of existing roads in desert tortoise habitat, with non-emergency maintenance activities being allowed only from October 15 to March 15. The BLM will implement route designation within the Pakoon WHA. Roads targeted for closure will include those that 1) have no purpose; 2) are duplicative or redundant; or 3) are causing high levels of mortality of tortoises. Implementation of the closure/designation plan will include the following actions 1) sign entry portals/major intersections with signs that read "Limited to Designated Roads;" 2) sign all designated routes as open; and 3) sign along designated routes indicating that driving off of designated routes is not permitted. Other road management actions presented in the ASRMP apply as well.

The Pakoon WHA is designated primarily as both Specialized and Primitive Travel Management Areas (TMA). Specialized TMAs will be managed to provide for variety of motorized, non-motorized, and mechanical travel modes to serve existing and future recreational, traditional, casual, commercial, and private needs in remote, rustic settings, but not to the detriment or exclusion of the protection of resources. The Specialized TMA will be managed to serve the day-to-day needs of permit holders, such as ranchers on grazing allotments, and the management needs of local, state, and federal agencies. It will also serve the motorized and non-motorized needs of visitors engaged in activities such as viewing scenery and cultural resources, exploring, camping, hiking, picnicking, hunting, gathering, and studying nature.

Primitive TMAs will be managed to provide for adequate, but limited motorized travel to serve existing and future traditional, casual, some commercial, private, and emergency needs and for non-motorized, non-mechanized travel to serve existing and future recreational needs in the most remote, rustic settings, for the enhancement and protection of important resource values. The Primitive TMAs will be managed for minimal human activities, and to serve the occasional needs of those with permits for the use of resources, such as grazing or research, as well as private, state, and other land ownership needs and a variety of local, state, and Federal agency resource management needs. It will also serve the non-motorized/non-mechanized needs of primarily local, regional, and national visitors engaged in activities such as viewing scenery and cultural resources, backcountry exploring, and hunting. Settings will be managed to allow for few and widely scattered, rustic management facilities in mostly remote, natural-appearing areas where it may be necessary to protect and/or administer important resources.

Major routes accessing the Pakoon WHA and providing connections to routes within Specialized and Primitive TMAs are designated as Backways TMAs. The Backways TMAs will be managed as the primary travel system providing public entry from communities to the more remote and semi-primitive TMAs. The Backways TMAs will allow for interpretive developments and administrative facilities in mostly natural-appearing areas.

Subsidized Predators Management

The attraction of potential desert tortoise predators to project sites, including fire suppression activities, in desert tortoise habitat should be limited by properly disposing of all waste and reducing or eliminating project-related water sources. Powerlines should be minimized and if built, include anti-perching mechanisms to discourage raptors and corvids. Other subsidized predator management actions presented in the ASRMP apply as well.

Implementation Success

Projects and actions within desert tortoise Critical Habitat within the Pakoon Basin have not yet been implemented, though some may have been under review at the time this report was produced.

3.4.3 Gold Butte-Pakoon Conservation Area Plans: Nevada

Clark County Management Framework Plan (1983)

The Clark County Management Framework Plan (MFP) outlines land use decisions and provides a guide for management actions on BLM-managed lands in Clark County, including those within the Gold Butte-Pakoon Conservation Area. The plan recognized desert tortoise as a sensitive species, and required that mitigation measures be included in a plan of operation for mineral leases, including pre-construction surveys and movement of tortoises outside of the area of disturbance. The plan required that the BLM maintain viable populations of wild horses and burros in Gold Butte, though the plan also recommends that they be removed from grazing allotments by 1986 in order to avoid competition with livestock. Grazing allotments throughout Gold Butte were active with the stipulation that adequate amounts of ephemeral spring forage (at least 200 pounds) were available to desert tortoises. Grazing periods were recommended, and for the Gold Butte allotments included use between May 15 and February 15. The plan also recommended that an Allotment Management Plan that considers desert tortoise be developed for Gold Butte, and that large exclosures be maintained for study of the effects of grazing. Recreational uses were encouraged, including an objective to provide OHV users a spectrum of opportunities ranging from individual, casual travel to highly organized competitive events. OHV use within Gold Butte was limited to "existing roads, trails, and washes," rather than any designated routes. Up to three OHV events could be approved in Gold Butte, though the events were limited to no more than three laps, required pitting in designated areas, confined to existing roads, courses, trails, and washes, and held between October and April. Fire plans did not identify desert tortoise habitat as a priority for suppression activities. The plan encouraged the development of waters and watering features such as guzzlers for wildlife, which likely subsidized tortoise predators. The plan recommended voluntary Section 7 consultation for projects or actions with the potential to impact desert tortoises, and limitations on projects and road development in crucial desert tortoise habitat. There were recommendations for the development of Habitat Management Plans targeted at desert tortoise conservation, but one was not recommended for Gold Butte.

Implementation Success

The Las Vegas Resource Management Plan (1998) was developed in response to a determination during a regularly scheduled review of the MFP that deemed the MFP did not adequately address providing desert tortoise protection consistent with the USFWS recommendations, as well as the rapidly changing public land use demands in Clark County.

Las Vegas Resource Management Plan (1998)

Plan Details

The 1998 Las Vegas Resource Management Plan (LVRMP) outlines the various decisions and management guidelines of resources on approximately 3.3 million acres of public land in Clark and southern Nye Counties, Nevada. The LVRMP identified implementation of the 1994 Recovery Plan as being the highest priority. To that end the LVRMP designated four ACECs specifically for desert tortoise and several others that contained desert tortoise habitat. The designation of one ACEC (Gold Butte, Part

A) includes 185,138 acres of designated Critical Habitat for desert tortoise. The following management recommendations from the LVRMP apply to this and other ACECs that protect desert tortoise habitat:

- The ACECs will be closed to locatable minerals and solid leasables, but open to fluid mineral leasing that does not result in surface disturbances.
- Livestock grazing is not allowed in ACECs, and they will be managed for zero wild horses and burros.
- OHV use limited to designated roads and trails in the ACECs. Speed events are prohibited. A maximum of 10 permitted non-speed events will be allowed annually during the tortoise active season (3/1 to 10/31), with no more than 3 events per ACEC.
- Minimize impacts to desert tortoise habitat during fire suppression activities.
- Inventory, monitoring, and research studies will be initiated within ACECs.
- No new landfills will be authorized.
- Military activities will not be authorized.
- Desert tortoise-proof fencing may be installed on selected highways and moderately-to-heavily traveled dirt roads, with culverts placed to allow tortoises to cross under the roadways.
- Disturbed lands will be restored following an action that degrades tortoise habitat.
- Temporary roads should be reclaimed and new roads should only be authorized in response to specific proposed actions where no feasible alternative exists.
- Utility corridors will be limited to 3,000 feet or less in width
- Approved fire suppression actions will be prescribed in ACECs in subsequent activity plans

Implementation Success

A number of ACECs were designated upon approval of the LVRMP, including the Gold Butte, Virgin Slope, Red Rock Springs, Devil's Throat, Whitney Pocket, and the Gold Butte Town Site ACECs, as well as a portion of the Virgin Mountains ACEC. Establishment of the ACECs provided the impetus for adding protection to desert tortoises and their habitat, including closure of mineral leases, closure of livestock grazing allotments, and limiting OHV travel to designated routes. Importantly, a total of 225,952 acres of designated Critical Habitat is included within these ACECs.

The LVRMP has largely been successful in implementing measures that were consistent with the 1994 Recovery Plan, with the exception of livestock grazing. Though the allotments were officially retired, trespass continues to be a problem from illegal livestock grazing on retired allotments and trespass by cattle on legal allotments on the Virgin Slope in Arizona.

Southern Nevada Public Land Management Act (1998)

Plan Details

The Southern Nevada Public Land Management Act (SNPLMA) became law in October 1998. It allows the Bureau of Land Management to sell public land within a specific boundary around Las Vegas, Nevada. The revenue derived from land sales is split between the State of Nevada General Education Fund (5%), the Southern Nevada Water Authority (10%), and a special account available to the Secretary of the Interior for: parks, trails, and natural areas; capital improvements; conservation initiatives; Multi-Species Habitat Conservation Plans; Environmentally Sensitive Land acquisitions; and Lake Tahoe

Restoration Act projects. The revenues available to the Secretary of the Interior may also be used by various agencies to purchase or restore desert tortoise habitat.

Implementation Success

The SNPLMA has been very successful in providing opportunities for recovery efforts within the Nevada portion of the Gold Butte-Pakoon Conservation Area. Through 2008 SNPLMA funds have contributed to a number of projects, including the development of plans, acquisition of lands, closure of mines, cleaning of trash dumps, implementation of air quality measures, and restoration of desert tortoise habitat (Table 19).

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
(BL18)	5-17: Interdisciplinary Management Plan for Gold Butte, an Area of Special Designation Experiencing Increasingly Extensive Recreational Use	Escalating development in the Las Vegas metropolitan area has lead to increased impacts in the once isolated Gold Butte area, designated by BLM as an Area of Critical Environmental Concern. Due to the growing popularity of the 350,000-acre Gold Butte area and the value of the significant resources it contains, a planned response to increasing visitation is required. This project involves studies that will establish a management plan that takes into account natural and cultural resource protection, habitat restoration, threatened and endangered species management, education and interpretation, recreation and travel.	$3,481,500	Approved date 8/6/04 In progress
(BL45)	6-21: Clark County Abandoned Mine Inventory	Abandoned mine lands pose a threat to visitors of the public lands in Clark County. Since 1971, thirty incidents (e.g., serious injuries and death) involving abandoned mine lands have occurred in Nevada, and eight of those incidences occurred in Clark County. According to the Nevada Division of Minerals (NDOM) 1,584 abandoned mine hazards have been identified in Clark County, of which 1,190 have been secured. Until a thorough inventory is conducted in Clark County, it is unknown how many safety hazards truly exist. The proposed project will continue a BLM/NDOM partnership in conducting an inventory over the next three years to identify the remaining abandoned mine openings in Clark County, Nevada.	$464,035	Approved date 2/18/06 In progress
(BL16)	2-20: Delavan Properties	The 861.11 acres is comprised of three separate patented mining claims surrounded by BLM lands. The property is located on the western	$140,200	Approved date 6/27/01 Closed out

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
		side of the Gold Butte ACEC almost entirely within the boundaries of the Lime Canyon Wilderness Area. Access to the area is the Gold Butte Back Country Byway, which lies along the eastern edge of Lime Ridge. Except for few small roads leading from some water developments at the foot of Lime Ridge (but outside the WSA), the area west of the byway has no roads. Access to the Delavan properties is by foot. The property provides habitat for desert tortoise, Bighorn sheep and several special status plants. The property was acquired by the BLM in 2005.		
(BL53)	6-29: Recreation Area Management Plans (RAMPs)	The proposed project provides for the creation of four Recreation Area Management Plans (RAMPs) out of nine identified by the Las Vegas Resource Management Plan as necessary to be completed in furthering the management direction for recreation opportunities on public lands. This project completes a necessary step in an overall Recreation and OHV Strategy for Southern Nevada.	$2,041,600	Approved date 2/18/06 In progress
(BL61, FW61, NP61)	8-4: Fire History, Fire Effects, and Postfire Seeding in Southern Nevada: Compilation of Fire Histories and Evaluation of Past and Future Fires and Seeding	The Bureau of Land Management, US Fish and Wildlife Service, and National Park Service are requesting SNPLMA Round 8 funds to compile fire histories and conduct surveys to evaluate current vegetation conditions on past fires and postfire seeding treatments in Clark and Lincoln counties of southern Nevada. Personnel that will be collecting these data will also be available for redirection to collect time-sensitive data associated with the effects of new fires that may occur, and evaluating in detail the effectiveness of seeding treatments that may be applied on these new fires. These capabilities extend well beyond the current monitoring capacity of Federal land managers, and get into the realm of scientific inquiry, which is why researchers from the USGS will be largely responsible for implementing this project. Collectively this research plan will provide much of the critical information needed by land managers to effectively and efficiently manage fire in southern Nevada.	$1,115,409	Approved date 2/21/08 In progress

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
(BL39)	6-28: Permanent Closure of Abandoned Mine Land Sites, Clark County	There are a large number of abandoned mines located on the public lands in Clark County. Many of these sites are dangerous and represent a hazard to public safety. These sites are often difficult to see and are in close proximity to existing roads, trails, and are located in heavily used recreational areas.	$599,500	Approved date 2/18/06 In progress
(BL36, NP36)	6-10: Rehabilitation of Public Lands Through Reclamation of Trash Dumps and Orphan Mine Sites	Trash dumps and orphan mine sites pose a variety of problems for the federal agencies who manage the land. The sites can contain any number of open trenches, open pits, buildings, abandoned vehicles, mining equipment, hazardous waste, trash, etc. Both the public and wildlife, including the Desert Tortoise, can be injured or killed on these sites. The disturbance and structures attract vandalism and more illegal dumping, resulting in a greater loss of habitat, visual resources and destruction of nearby cultural sites. This project would allow the BLM and the NPS to restore a number of trash dumps and orphan mine sites to their pre-disturbed states. Habitat and visual resources will be restored.	$2,200,000	Approved date 2/18/06 In progress
(BL10, FS10, FW10, NP10)	4-11: Invasive Weed Removal and Habitat Restoration	It is proposed that the four federal land management agencies in Southern Nevada develop a comprehensive partnership approach to help overall restoration needs. The goals of the proposal are: 1. Establish a coordinated database and protocol for documenting disturbances and areas in need of restoration that will enable regional assessments of overall need and assist in prioritization of future habitat restoration projects. 2. Establish a coordinated procedure for documenting and monitoring individual habitat restoration projects and the effectiveness of individual projects and techniques. 3. Provide for contracted assistance in project development and management that will augment existing project management capabilities. 4. Implement high priority habitat restoration projects for each of the four agencies. 5. Augment existing weed inventory and management programs for rapid response to newly	$5,824,500	Approved date 10/29/03 In progress

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
		found populations of weeds. 6. Create job opportunities for the community through contracts, agreements and supply purchases totaling $5,295,000 with no additional federal employees. 7. Monitor effectiveness and efficiency of the overall habitat restoration program through monitoring and documentation, and analysis of regional needs.		
(BL14, FS14, FW14, NP14)	Interagency Restoration - Weed Management, Phase II	More than five years ago, the four federal land management agencies established a Southern Nevada Restoration Team (SNRT). The goal of SNRT is to work cooperatively to restore sensitive and unique habitats through community involvement, education, research, and project implementation. This project will generate opportunities to involve the public through the Interagency Volunteer Program, Partners in Conservation, Student Conservation Association, and other cooperative programs. One of the primary goals of SNRT is to educate the public about desert systems and their restoration. Expected results include increased rehabilitation area with efficient seed dispersal over large areas through the development and testing of mechanized seed pelleting techniques; expanded treatment of top non-native invasive plants; promotion of desert tortoise viability through the propagation and field-testing of a reliable seed source of native plants known to be nutritious to the desert tortoise; development of propagation and seed production protocols to be used in pilot desert restoration studies; development of a seed-banking facility for the effective storage of native seed; development of effective treatment protocols for the invasive Sahara mustard.	$5,140,666	Approved date 8/6/04 In progress
(BL24, FS24)	Implementation of Dust Mitigation Plans for USDA FS and BLM in Southern Nevada	The Las Vegas Valley ""nonattainment area"" (an area where air pollution levels persistently exceed the national ambient air quality) has a severe airborne dust and Carbon Monoxide (CO) air-pollution problem. Levels of particulate matter under 10 microns in size within the valley and surrounding air shed exceed the national	$2,451,440	Approved date 8/6/04 In progress

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
		standards for human health and safety set by the EPA per the Clean Air Act. This project will include strategic enforcement planning and action; identification of chronic "hot spots" of dust production and illegal OHV activity; accurate inventories of emissions from legal activities; and community outreach for the prevention of illegal activities that add to the air pollution problem		
(BL25, FS25, FW25, NP25)	Improving Visitor Safety and Conserving Biological and Cultural Resources at Abandoned Mine Sites	To increase visitor safety, thousands of abandoned mines have been identified for closure on the public lands. Cultural resources and habitat could be lost or damaged depending upon the type of mine-safeing method used. Results of this project include cultural resource inventory report of highest-priority mine sites, photo documentation and consultation with the State Historic Preservation Office; biological resource inventory report of highest-priority mine sites, documentation of species present, qualification of habitat significance for each species, level and seasonality of use, and recommendations for closure methods; post-closure monitoring of abandoned mines closed with bat gates; and facilitation of responsible elimination of a serious safety risk on the public lands.	$1,531,860	Approved date 8/6/04 In progress
(BL33, FS33, FW33, NP33)	Habitat Restoration - Program Sustainability	The federal land management agencies in southern Nevada continue to work collaboratively on interagency restoration projects through the Southern Nevada Restoration Team (SNRT). Round 4 has allowed SNRT to identify over 1,000 acres per year of upland and riparian treatments, including the Virgin River. This proposed project will sustain the program and continue to build capacity. The restoration database started in Round 4 will be maintained and high priority projects will be implemented through contracts and agreements. In addition, this project will provide support for habitat restoration and protection projects that were recommended, but not funded, through Clark County's Multiple Species Habitat Conservation Plan (MSHCP) because the County's implementation budget	$8,884,502	Approved date 2/18/06 In progress

Table 19. Projects Funded through the Southern Nevada Public Land Management Act (SNPLMA)

Project Number	Project Title	Project Description	Funding Amount	Contract Term
		(i.e. Section 10 Funds) was exceeded.		
Information taken from BLM Website (http://www.blm.gov/nv/st/en/snplma/snplma_prephase_1.html)				

Clark County Multiple Species Habitat Conservation Plan (2000)

Plan Details

The Clark County Multiple Species Habitat Conservation Plan (MSHCP) plan area includes all of Clark County. In addition, specifically for the desert tortoise, the MSHCP plan area also includes Nevada Department of Transportation rights-of-way (including material sites) below 5,000 feet in elevation, south of the 38th parallel in Nye, Lincoln, Mineral, and Esmeralda Counties. It is estimated that Clark County supports more than 3.5 million acres of desert tortoise habitat and the 10(a) Permit area includes an estimated 418,200 acres with potential for development. The MSHCP imposes a $550-per-acre development fee for the implementation of an endowment fund that funds various efforts designed to conserve and manage wildlife habitat. The following recommendations in the plan pertain to managing desert tortoise populations and their habitat:

- In cooperation with BLM, Clark County should jointly designate, close, and rehabilitate unpaved roads.
- New landfills should be sited away from susceptible desert tortoise populations and habitat areas and appropriate landfill management should be implemented.
- New utility towers should have design features incorporated to inhibit raptor or raven perching and nesting, and existing towers should be retrofitted with devices anti-perching devices.
- Impacts to desert tortoise populations from livestock grazing should be decreased through the use of fencing, removal, and management of herds.
- Grazing allotments should be purchased by the County on a willing-seller, willing-buyer basis.
- When individuals holding valid mining claims propose to disturb any land not previously disturbed, the claimant should file a mining notice or a mining plan of operation with the BLM. If the plan of operation is liable to affect a federally listed species, a Section 7 consultation should be required. Mining notices do not normally require Section 7 consultation outside of ACECs. Within ACECs, all grandfathered mining activities will be required to submit a mining plan of operation prior to surface disturbance activities.

Implementation Success

The MSHCP has been very successful in providing opportunities for recovery efforts within the Nevada portion of the Gold Butte-Pakoon Conservation Area. Through 2008 MSHCP funds have contributed to a number of research, monitoring, restoration, education, land acquisition, and mine closure projects that target the recovery of desert tortoise populations within the Gold Butte-Pakoon ACEC (Table 20).

Table 20. Projects Funded through the Clark County MSHCP

Project Number	Project Title	Project Description	Funding Amount	Contract Term
2003-BLM-361	Evaluating the Impact of Cattle Grazing on Vegetation & Vegetative Recovery Following Removal of Cattle Grazing	This project resampled vegetation trend plots in all areas within critical desert tortoise habitat where grazing was removed. Data was used to determine species diversity and investigate the effects of cattle grazing on desert tortoise habitat.	$160,200	1/6/04 thru 2/28/06
2005-RRCIA-559A	Mojave Max Education Program Development	This program provided information to the public through school presentations, teacher training classes, online contest and community appearances regarding *desert tortoises*. Program encouraged thousands of students a year to "respect, protect and enjoy our desert."	$400,000	9/4/07 thru 12/31/11
2005-UNR-567	Epidemiology of the Desert Tortoise	This project researched mechanisms which causes disease and decline of *desert tortoise* populations. Primary goal was to evaluate immune status of natural populations and develop indicators of environmental stress.	$779,726	7/17/07 thru 11/1/09
2005-UNR-576	Movements and Barriers to Movement in the Desert Tortoise *(Gopherus agassizii)*	This project used highly variable nuclear DNA markers in *desert tortoise* population in Clark County to protect the diversity through ID of conservation units, clarify the genetic structure among populations of the landscape shape this structure, identify patterns of movement and initiate hypothesis testing, and provide managers with info necessary to restore and maintain these patterns.	$719,210	7/17/07 thru 1/31/09
2005-UNR-585	Desert Tortoise Monitoring	This project was to assist the USFWS with their *desert tortoise* monitor training program. It was to develop more efficient training and monitoring techniques to effectively track trends in the tortoise population in Clark County.	$1,217,072	4/30/07 thru 11/2/09
2005-USFWS-585A & 2007-USFWS-785	Desert Tortoise Monitoring & Desert Tortoise Monitoring 2009	This project implemented 2005 monitoring protocol and improvements. Some improvements addressed the proposed objectives of increasing precision and developing a mechanism for characterizing the distribution of tortoises in Clark County. Other improvements, however, are general quality assurance steps that increase confidence in the quality and applicability of the data for answering questions about distribution and abundance of *desert tortoises*. Training and planning received concentrated attention in 2008, and corresponding improvements were seen in data quality control and in ability to complete transects in hard-to-reach areas (more representative sampling).	$1,372,218 & $983,000	9/18/07 thru 10/1/09 & 10/29/08 thru 3/31/10
2005-NTU-602A	Impact of Nutritional Stress on Upper Respiratory Tract	This study is to further research in the understanding of interactions between nutrition, immune function, and Respiratory	$698,480	3/17/09 thru 4/15/11

Table 20. Projects Funded through the Clark County MSHCP

Project Number	Project Title	Project Description	Funding Amount	Contract Term
	Disease and Immune Function in the Desert Tortoise	Tract Disease (URTD) via controlled dietary studies, independent challenge to the immune system and experimental infection of tortoises with a causative agent of URTD. University of North Texas assumed the lead role for this project when the Smithsonian Institute was unable to initiate the project. (Formerly project 2005-Smithsonian-602)		
2003-BLM-361	Evaluating the Impact of Cattle Grazing on Vegetation and Vegetative Recovery Following Removal of Cattle Grazing	The purpose of this project was to resample vegetation trend plots in all areas within critical desert tortoise habitat where grazing had been removed. This project collected data during trend analysis which included frequency and cover. This data was used to determine species diversity and to investigate the effects of cattle grazing on desert tortoise habitat.	$160,200	1/6/04 thru 2/28/06
2007-BUSCHELMAN-722A	Surface Water Rights Consulting	The Clark County DCP acquired several stock water rights as a result of purchasing grazing allotments with the intent of providing undivided 1/3 interest to the Bureau of Land Management (BLM), Nevada Division of Wildlife and Clark County. In order for Clark County to hold permitted water rights, a series of applications, reports of conveyance, extensions of time, abstracts of water right titles, and proofs of completion and beneficial use needed to be completed and filed by Clark County and accepted by the Office of the State Engineer. The DCP hired Buschelman Consulting, Inc. to prepare and file the necessary paperwork to establish Clark County as the owner of record and to obtain permitted water rights on the remaining 33 of the original 59 surface water rights. The manner of use for the base rights was also to be changed from stock water to wildlife and habitat preservation. • Confirmed the closure of the Gold Butte Grazing Allotment per BLM letter and acceptance by the Office of the State Engineer • Conducted initial negotiations with The Nature Conservancy (TNC) concerning 19 stock water rights associated with Gold Butte grazing allotment Gold Butte grazing allotment water rights were conveyed to TNC from the Frei Family • Awaiting TNC to convert the manner of use for the Gold Butte water rights to wildlife and habitat preservation, or convey a Water Right Deed to Clark County,	$31,600	12/17/07 thru 1/31/12

Table 20. Projects Funded through the Clark County MSHCP

Project Number	Project Title	Project Description	Funding Amount	Contract Term
		allowing Clark County to proceed with conversion of the manner of use to wildlife and habitat preservation		
Information was obtained from the Desert Conservation Program 2007-2009 biennium progress report. (http://www.accessclarkcounty.com/depts/daqem/epd/dcp/Documents/DesertConservationProgram%20BienniumReportForThe2007-2009_Biennium.pdf)				

3.4.4 Superior-Cronese Conservation Area Plans

California Statewide Desert Tortoise Management Policy (1993)

Plan Details

The BLM's California Statewide Desert Tortoise Management Policy (CSDTMP) was intended as supplement to the DTHMPL (1988) and specified how the management actions in the Rangewide Plan would be applied in the state. The same categories (Categories I-III, with I being the highest quality) used in the DTHMPL was applied to desert tortoise habitat areas within California. Seven management goals (MG) were established in CSDTMP that were primarily focused on restoring and maintaining stable populations in Category I and II habitat areas, while also preventing deterioration and promoting restoration of the habitats within the two categories. Impacts to desert tortoises in Category III habitat areas would be minimized through mitigation and land compensation. Proposed habitat loss due to approved projects on any of the categorized habitat areas would be mitigated through land acquisitions that would help consolidate Category I and II habitat areas.

In order to achieve the MGs for the Categories, 40 guidelines (G) with associated implementation strategies and discussion were established. These included the following:

- MG A sought to restore and maintain stable desert tortoise populations with Category I and II habitat areas. Establishing categories based upon criteria from the DTHMPL was the sole Guideline (G 1) set for the goal.
- MG B sought to minimize impacts to tortoises in Category III habitat areas by using humane and low level mitigation measure (G 2), and acquiring Category I or III through exchange or disposal of Category III (G 3).
- MG C sought to reduce non-natural desert tortoise mortality through public education programs (G 4); the return of recently captive tortoises to point of capture (G 5); adoption of domestic tortoises to BLM-approved entities (G 6); reexamination of vehicle routes (G 7); installation of tortoise-proof fences in Category I and II habitat areas along highways, roads, canals, aqueducts, mine shafts, and other manmade pitfalls that are known or expected to have high losses of tortoises(G 8, G 9, G 10, and G 11); competitive OHV event would be restricted to designated areas and no new OHV areas would be established in Category I and II habitat areas, and those established adjacent would need a functional barrier (G 12, G 13, and G 14); enforcement of existing laws, regulations, rules pertaining to the protection of tortoise (G 15); establishment of shooting closures in areas when tortoise are active (G 16); the implementation of raven management plan (G 17); and implementing studies to determine if water guzzlers subsidize canid predation on desert tortoise (G 18).
- MG D sought to prevent deterioration and promote restoration of Category I and II habitat areas through the reevaluation of sheep grazing (G 19); surface disturbance activities would be

restricted to operations that cannot be relocated (G 20); mitigation measures required to minimize surface disturbance to soil and vegetation, including rehabilitation and restoration (G 21 and G22); compensation of lands for residual habitat degradation and loss (G 23); the discouragement of facilities and activities that concentrate visitors (G 24); modification of management practices of established tortoise preserves (G 25); no Category I habitat areas would be transferred from public ownership and Category II habitat areas exchanges would only be approved for equivalent or greater areas of Category I and II habitat areas (G 26 and G 27); and public funds would be used to restore and rehabilitate prior adverse impacts (G 28).

- MG E sought to consolidate Category I and II habitat areas through habitat acquisition and as compensation for losses of areas within each category. This was proposed to be accomplished by establishing a standard process for determining compensation (G 29) and using public funds (G 30).
- MG F sought to maintain and increase desert tortoise populations through the translocation of wild tortoise using experimental determines translocations effectiveness (G 31) and by determining unoccupied or depleted habitats within the tortoise's historic range that could be used for the process (G 32).
- MG G sought to establish interagency coordination in order to demonstrate the commitment necessary to maintain viable desert tortoise populations in California. This was proposed to be accomplished by the implementation of habitat management plans or coordinate resource management plans would be prepared (G 33); establishment of Category I and II habitat areas as sensitive areas for consultation with US Fish and Wildlife Service (G 34); and encouraging other agencies to adopt the guidelines in the CSDTMP (G 35).
- MG H sought to develop and implement a monitoring program that would determine the progress of meeting the other MGS efforts in maintaining viable populations of desert tortoise. This was proposed to be accomplished by continuing surveys on four of fifteen trend plots each year (G 36); compilation and examination of the mitigation measures and stipulations that are intended to benefit tortoises (G 37); requiring compliance reports for all projects that require mitigation measures in regards to tortoises (G 38); the establishment of additional research test plots (G39); and the development of a methodology to track desert tortoise habitat acquisition, enhancements, and losses (G 40).

Implementation Success

In October 1992, the State Director signed the CSDTMP, which designated 620,100 acres as Category I habitat areas and 171,200 acres as Category II (BLM lands only). In April 1993, the BLM amended the California Desert Conservation Area Plan to delineate these three categories of desert tortoise habitat on public lands. Many of the guidelines proposed in the CSDTMP were incorporated into the BLM's West Mojave Plan (2006).

California Desert Conservation Area Plan 1980 as Amended (1999)

Plan Details

The California Desert Conservation Area (CDCA) was designated by Congress in 1976 under the Federal Land Policy and Management Act, and includes 25 million acres across the deserts of southern California. Approximately 10 million acres are managed by the BLM. Congress charged the BLM with developing a long-range plan for the management, use, development and protection of the public lands within the conservation area. The BLM originally published the CDCA Plan in 1980; however by 1999 147 amendments had been added to the plan, which prompted the BLM to publish a reprint of the 1980 plan abridged with the amendments (BLM 1999). The CDCA Plan provides general, regional guidance for

management of the plan area over at least a 20-year time period. The CDCA Plan is at the top of a hierarchy that provides a framework for subsequent plans for specific resources and uses, and for the development of site-specific programs or project actions in a manner that is responsive to specific land-use requests. The CDCA Plan covers an area containing over 12 million acres of public lands, the majority of which are under BLM management. Several Areas of Critical Environmental Concern were designated within the CDCA Plan. Plan area lands were also designated geographically into four multiple-use classes based on the sensitivity of resources and kinds of uses for each geographic area: Class C (controlled), Class L (limited use), Class M (moderate use), and Class I (intensive use). Classes C and L were designated in higher quality habitats with limited manmade impacts and deemed as more valuable to the persistence of desert tortoise populations. The plan describes resources and land uses for twelve elements. Some of the guidelines within the elements pertain to the management of desert tortoises and their habitat (Classes C and L) include the following:

- For Class C habitats, motorized-vehicle use is generally not allowed unless provided for in individual wilderness legislation and management plans, or if necessary to serve valid existing rights, and for emergency use.
- New roads may be developed in Class L habitats under right-of-way grants or pursuant to regulations or approved plans of operation.
- New railroads are not allowed in Class C habitats and only allowed in Class L habitats if no other viable alternative is possible.
- All Class C habitats designated as wilderness areas may be withdrawn from mineral entry at sometime and following withdrawal, no new mining claims may be located and no new permits, leases, or material sales contracts may be issued subject to deadlines established by Congress.
- New mines would be allowed in Class L habitats if mitigation and reclamation measures are implemented to protect and rehabilitate sensitive scenic, ecological, wildlife vegetative and cultural values.
- Electric generation plants, new transmission facilities, gas, water and telecommunication lines are not allowed in Class C habitats and new licenses or rights- of-way for these purposes are not be granted.
- For Class L habitats, new gas, electric, and water transmission facilities and cables for interstate communication are to be allowed only within designated corridors.
- Allotments classified as ephemeral sheep operations are to be managed under ephemeral authorizations. Authorizations are to be issued after an interdisciplinary team, along with grazing operators involved, makes a field examination of the allotment to determine whether production of 200 pounds per acre of dry weight will be available for turnout, except in highly crucial desert tortoise habitat, where a 350 pounds-per-acre requirement is specified. These restrictions pertain to both sheep and cattle operations.
- For Both Class C and L habitats, fire suppression measures are to be taken in accordance with specific wilderness fire management plans to be followed by the authorized officer, and may include use of motorized vehicles, aircraft, and fire retardant chemicals.

On March 16, 2000, the Center for Biological Diversity, the Sierra Club, and the Public Employees for Environmental Responsibility filed a lawsuit against the BLM, alleging that the Section 7 process of the ESA had been sidestepped during the development of the CDCA Plan and its amendments. This suit led to an agreement whereby the BLM was charged with developing an amendment to the CDCA Plan that included an additional 58 interim measures aimed at special-status species recovery. Those pertaining to desert tortoise populations in the Superior-Cronese Conservation Area, as presented in their final form in

the Biological Opinion (USFWS 2002) for the action included emergency road closures, closure of areas to shooting, encouragement of camping at previously disturbed sites, elimination of OHV use off of designated routes, burro removal, implementation of grazing prescriptions (Table 21), complete exclusion of the Pilot Knob allotment until the West Mojave Plan was signed, and development and implementation of road maintenance rules that would minimize entrapment of desert tortoises, as well as applicable terms and conditions and reasonable and prudent measures (USFWS 2002). The BLM consulted with the USFWS in support of amendments to the CDCA Plan, including one for that addressed plans for the Northern and Eastern Mojave Desert and the Northern and Eastern Colorado Desert (USFWS 2005), and one that designated routes in the West Mojave Plan area (USFWS 2003).

Table 21. Grazing prescriptions approved for allotments within the Superior-Cronese Conservation Area for the 2002 Amendment to the CDCA Plan (USFWS 2002)

Allotment	Acres	Acres of Exclusion	Acres of CH	Acreage of Excluded CH	Spring Limits	Fall Limits	Animal-Days Limits
Pilot Knob	64,810	64,810	48,280	48,280	Year-round exclusion	Year-round exclusion	0
Cronese Lakes	65,304	18,000	30,080	18,000	March 1 - June 15	September 7 - November 7	13,383
Harper Dry Lake	26,314	18,954	16,482	16,482	March 1 - June 15	September 7 - November 7	17,033

<u>Implementation Success</u>

Manix Trail

Ft. Irwin initiated Section 7 consultation with the USFWS in 1991 in support of base operations and training activities in desert tortoise habitat on and adjacent to the base. The Biological Opinion (USFWS 1991c) outlined a number of measures, including several for Manix Trail. Specifically, the USFWS required that Manix Trail be demarcated with physical barriers or prominent markings and that tortoises be moved "out of harm's way" before passage of convoys by using a lead vehicle with a trained observer watching the road.

Linear Utility Construction and Maintenance

The BLM initiated Section 7 consultation with the USFWS in 1995 in support of maintenance activities performed by the Southern California Gas Company on natural gas pipelines on BLM-managed lands. In the Biological Opinion, the USFWS required a series of measures that were dependent on the level of disturbance caused by the activity. The measures included worker environmental training, travel on existing roads, removing trash from project sites, prohibitions on pets and guns at project sites, checking under vehicles for tortoises before moving, biological monitor(s) on site who can move tortoises that wander onto the project site, restricting road maintenance activities to between October 15 and March 1 or June 15 through August 1, preconstruction surveys by an approved biologist, removal of tortoises from burrows within project sites by an approved biologist, and flagging of work areas by an approved biologist, among other protective measures (USFWS 1995d; 1996d). Similarly, the BLM consulted with the USFWS in 1999 in support of maintenance activities performed by Pacific Gas & Electric Company on natural gas pipelines on BLM-managed lands. The opinion carried similar measures applied to the Southern California Gas Company opinion (USFWS 2000b).

The BLM consulted with the USFWS in 2000 in support of the installation of the Level 3 fiber optic line within the existing utility corridor that crosses the Superior-Cronese Conservation Area. In the Biological

Opinion, the USFWS required that the project site be fenced with tortoise-proof fencing, as well as the aforementioned measures for pipeline maintenance (USFWS 2001).

Smaller Actions

The BLM's California Desert District initiated Section 7 consultation with the USFWS in 1992 in support of small mining and exploration operations in the California desert that were cumulatively not to exceed ten acres (USFWS 1992a). The BLM reinitiated consultation in 1994 following designation of Critical Habitat, and the opinion from the USFWS essentially remained unchanged (USFWS 1994e). Similarly, the BLM initiated Section 7 consultation in 1997 in support of small projects that result in small areas (<2 acres) of disturbance to desert tortoise habitat. The Biological Opinion allowed loss of up to 10 acres of desert tortoise Critical Habitat within a recovery unit per year (USFWS 1997c). Covered actions include disturbance of soils, placement of machinery, exclusion of areas from wildlife use, and construction of permanent structures. Cumulatively, the small actions may total up to 80 acres on BLM lands within the Western Mojave Desert Recovery Unit. The Biological Opinion included measures that minimize potential impacts to desert tortoises and their habitat within the project description, as well as measures that describe how the project proponent would compensate for habitat that is permanently lost (USFWS 1997c).

As part of mitigating potential loss of tortoises on a stretch of road leading to a solar electric plant project site, the BLM consulted with the USFWS in support of constructing a tortoise-proof fence and culvert crossings along Harper Lake Road in an area that bordered the Superior-Cronese Critical Habitat Unit (USFWS 1995c).

Road Widening and Maintenance

The Federal Highway Administration conducted Section 7 consultations with the USFWS in support of road construction and maintenance activities. Although these actions were not proposed by the BLM, they affect desert tortoises on BLM lands and are worth mentioning. In particular, the Ft. Irwin Road widening project included installation of tortoise exclusionary fencing on both sides of the road in order to reduce vehicle-tortoise strikes (USFWS 2002b). The road passes over several drainage structures that provide crossing opportunities for tortoises, allowing for dispersal and gene flow. Two other Biological Opinions issued for Federal Highway Administration actions allowed Caltrans to perform road maintenance activities in the vicinity of the Superior-Cronese Conservation Area (USFWS 1994f; 2006c).

West Mojave Plan – Record of Decision – Amendment to the California Desert Conservation Area Plan (2006)

<u>Plan Details</u>

The BLM produced the West Mojave Plan (WEMO) as an amendment to the CDCA for public lands and a habitat conservation plan for private lands. The WEMO is a federal land use plan amendment that presents a strategy to conserve and protect desert tortoise, Mohave ground squirrel, and nearly 100 other special-status species and natural communities, and provides a plan for complying with CESA and ESA (BLM et al. 2005). The WEMO contains four goals for desert tortoise conservation:

> **Goal 1:** Protect sufficient habitat to ensure long-term tortoise population viability.
>
> **Goal 2:** Establish an upward or stationary trend in the tortoise population of the West Mojave Recovery Unit for at least 25 years.

Goal 3: Ensure genetic connectivity among desert tortoise populations in the West Mojave Recovery Unit, and between this and other recovery units.

Goal 4: Reduce tortoise mortality resulting from interspecific (i.e. raven predation) and intraspecific (i.e. disease) conflicts that likely result from human-induced changes in the ecosystem processes.

The following specific recommendations are contained in the WEMO that pertain to desert tortoise populations and their habitat:

- Designate the Superior-Cronese Critical Habitat Unit (or DWMA) an ACEC, and manage lands therein as Class L (limited use).
- In general, there would be no new paved highways in DWMAs, except an established list of projects. The West Mojave Plan would provide coverage for these projects and the acreage (1,833 acres total) would serve as the CalTrans Allowable Ground Disturbance. Additional proposals for paved roads would not be covered by the WEMO, and would be subject to separate consultations. Proponents wishing to construct new roads or railroads are encouraged to locate them outside of DWMAs and should implement designs and maintenance procedures that are consistent with the existing terms and conditions identified in various pertinent biological opinions.
- Use of earth-moving equipment or vehicle travel off public roads and designated open routes would not be allowed except under a BLM approved Plan of Operations for exploration activities conducted in accordance with the General Mining Law of 1872.
- With the exception of the Barstow Landfill expansion, the planning of which was initiated prior to development of the WEMO, counties and cities would ensure that no new landfills are constructed inside DWMAs or within five miles of them.
- To the degree possible, new utility right-of-ways in BLM-designated, active and contingent corridors would be situated as closely together as practical given engineering specifications, human safety, and other limiting factors. Within existing corridors, areas that are already disturbed will be used rather than undisturbed areas within the two- to three-mile wide corridor.
- The network of motorized vehicle access routes in the West Mojave that was adopted on June 30, 2003 achieved most of the objectives of the CDCA Plan. Modifications were made with the additional public review of the WEMO to better protect rare species and their habitat, connect travel routes among subregions, allow competitive use of routes outside sensitive habitat and curtail conflicts with private property. Deletion of the Barstow to Las Vegas race course from the 2002 Northern and Eastern Mojave Desert Amendment to CDCA left a fragment of this route remaining open in the West Mojave area. The amendment to delete the remaining one third of the race course is primarily an administrative action to achieve consistency in the CDCA. The competitive corridor between the Stoddard Valley and Johnson Valley Open Areas was changed to a non-competitive connector route and realigned to provide conformance with the 1994 Recovery Plan for desert tortoise, which recommended elimination of competitive events within DWMAs.
- The livestock grazing management prescriptions would be implemented for all cattle allotments managed by the BLM in the WEMO plan area that occur in desert tortoise habitat and within the Mohave Ground Squirrel Conservation Area. Grazing use would continue until lessee voluntarily relinquishes all grazing use. New cattle guards would be designed and installed to prevent entrapment of desert tortoises. All existing cattle guards in desert tortoise habitat would be modified within three years of plan adoption to prevent entrapment of desert tortoises. Any hazards to desert tortoises that may be created, such as auger holes and trenches, would be eliminated before the rancher, contractor, or work crew leaves the site.

- Wildland fire management would be allowed in all management areas and fire suppression would be a mix of aerial attack with fire retardant, crews using hand tools to create firebreaks, and mobile attack engines limited to public roads and designated open routes. The use of earth-moving equipment or vehicle travel off public roads and designated open routes would not be allowed, except in critical situations where needed to protect life and property. Post-suppression mitigation should include rehabilitation of firebreaks and other ground disturbances using methods compatible with management goals.
- Within two years of WEMO adoption, the Implementation Team, BLM, county animal control, and other applicable entities would develop a Feral Dog Management Plan. The Feral Dog Management Plan would, among other things, determine control measures and identify an implementation schedule. In order to limit the subsidization of desert tortoise predators landfills would ensure effective cover of waste multiple times each day; erect coyote-proof fencing; render raven-proof all sources of standing water at the landfill, and (iv) keep truck cleaning areas and temporary storage facilities clean and free from standing water and organic wastes (e.g., food material, biosolids, mixed solid waste, and other materials that may be consumed by common ravens and not including "green material" as defined in Section 17852 by the California Integrated Waste Management Board).
- Carcasses of road-killed animals along highways in desert tortoise habitat would be removed to limit their availability to potential predators of tortoises. The population density of ravens and number of birds that may predate on tortoises would be decreased by reducing the availability of water and raven nests. A raven reduction program would be initiated in areas where ravens are identified as preying on tortoises.

Implementation Success

A lawsuit filed in August 2006 by the Center of Biological Diversity et al. led to a decision in federal court to strike down the WEMO on September 28, 2009. The court rejected the BLM's use of a route designation decision making for designating OHV areas and failure to provide adequate explanation for many of the proposed route changes. Though the court's decision concluded that the BLM violated the Federal Land Policy and Management Act and National Environmental Policy Act (NEPA), the court found that a review of the WEMO's impacts on the desert tortoise undertaken by the USFWS complied with the federal Endangered Species Act (ESA).

Fort Irwin Land Expansion

Plan Details

In order to expand the battle-space environment for training Army brigade-sized units, the Department of Defense proposed to expand the boundaries of Fort Irwin into federal lands managed by the BLM. The lands were primarily located in the northern portion of the Superior-Cronese Critical Habitat Unit along the southern border of Ft. Irwin. The Land Expansion proposal included expansion into three areas including the Eastgate Area, the Southern Expansion Area (SEA), and Superior Valley. The Army proposed to expand into these areas in 2005, 2007, and 2010, respectively.

The proposed project was the subject of several Congressional actions and inter-agency coordination efforts involving the BLM and the USFWS. Public Law 106-554, H.R. 5666, Section 323, required the production of several documents in compliance with Congressional requirements, including a Key Elements Report (submitted to Congress on 4 January 2001), which identified the need for expansion and the history of efforts to expand Fort Irwin, identified threatened and endangered species issues, and elements of the project. The USFWS provided a Preliminary Review of the effects of the proposed

expansion on threatened and endangered species on 28 March 2001. Finally, a Proposed Expansion Plan was submitted to Congress on 13 July 2001. This plan combined the findings and recommendations of the prior two reports and set forth a plan to complete the expansion process.

The Army proposed a variety of mitigation measures to reduce, eliminate or offset direct, indirect and cumulative impacts of the proposed Land Expansion including (among other things):

- Creation of off-limits conservation areas for desert tortoise and Lane Mountain milk-vetch on Fort Irwin;
- Translocation of desert tortoises from expansion areas to BLM lands outside of the training area;
- Purchase of private mitigation lands within desert tortoise critical habitat, as identified in the Biological Opinion from USFWS;
- Purchase and voluntary retirement of cattle grazing allotments within desert tortoise habitat in the west Mojave Desert;
- Contribution towards the BLM West Mojave Plan route closures;
- Use of existing roads in all areas possible.

In 2001, the Omnibus Consolidated Appropriations Act of 2001 (Public Law 106-554) was enacted, which transferred approximately 118,000 acres of BLM-managed federal land to the Army. A total of $75 million was authorized under the law for conservation of desert tortoise and other listed species, based on the analysis of potential impacts of the proposed land expansion and outcome of the Section 7 consultation with the USFWS. The funds were appropriated to implement the following mitigation measures (among others), as identified in the Key Elements Report:

- To the extent practicable and consistent with its military needs, the Army would seek to manage appropriate areas of the UTM 90 Area in such a way as to protect the desert tortoise and its habitat.
- The BLM would designate an approximately 500 square kilometer area just south of Fort Irwin as an Area of Critical Environmental Concern (ACEC). Approximately 3100 acres of existing Fort Irwin lands would become part of this ACEC. This area encompasses critical habitat for the desert tortoise and establishes a land bridge between populations of desert tortoise located east and west of the installation. It also assures that Fort Irwin would not be expanded to the south in the future. The BLM would manage this ACEC for the protection and conservation of the desert tortoise and its habitat and for research on the desert tortoise.
- A Working Group, composed of staff from the Army, USFWS, CDFG, and BLM would evaluate proposals for land acquisition and other conservation measures (e.g., research needs and priorities, management practices) to ensure they meet the appropriate criteria and provide for adequate conservation of the species to offset the impacts of the proposed expansion. The USFWS would make the final determination as to whether any specific parcel of land should be acquired or whether any other conservation measure, including research, is appropriate and should be funded with the authorized appropriations. Conservation measures necessary to comply with the ESA may include, but are not limited to: 1) Establishment of ACECs which encompass wildlife management areas in the West Mojave Desert. The ACECs would provide special management attention to protect and prevent irreparable damage to important wildlife resources within areas (see 43 C.F.R. §1601.0-5); 2) establishment of Research Natural Areas (RNA), including the East Alvord Mountain and Paradise Valley RNAs. Establishment of a mechanism through the West Mojave Plan for designating additional RNAs to support future research as the need arises, which might include, for example, RNAs encompassing areas to which desert

tortoises are translocated; headstarting locations; epidemiological research; or urban interface studies; 3) acquisition of non-federal lands within the wildlife management areas in the West Mojave Desert. These areas would be segregated into distinct acquisition polygons, and priorities would be established for acquiring lands within those polygons. Lands would be acquired from willing sellers in areas with the greatest potential for contributing to the conservation and recovery of desert tortoise populations within the Western Mojave Tortoise Recovery Unit. Acquisition of desert tortoise habitat would include criteria such as a) desert tortoise occurrence; b) suitable desert tortoise habitat; c) overlap of desert tortoise habitat with habitat for other sensitive species.

- Construction of barriers, fences, and other structures that are designed primarily to conserve desert tortoise and designated critical habitat.
- Funding of research studies designed to protect and promote conservation of the desert tortoise and other endangered or threatened species and their critical habitats. The Working Group would make recommendations regarding research needs and priorities. The USFWS would make the final determination regarding the research projects that would be funded with the authorized appropriations;
- Other conservation measures that the Working Group may recommend as being necessary and appropriate to protect and promote the conservation of the desert tortoise and other endangered or threatened species and their critical habitats. The USFWS would make the final determination as to whether a conservation measure should be funded with the authorized appropriations. These might include, but would not be limited to: a) designation and implementation of a vehicle access network within the West Mojave wildlife management areas, including restoration of closed routes and signing. Particular consideration would be given to those areas where route designation and closure would best benefit the conservation of the desert tortoise and other special status species; b) establishment of a line distance sampling monitoring program for desert tortoise populations, to be implemented over 30 years throughout the West Mojave wildlife management areas based on the best available scientific information; c) an education program that promotes the conservation and recovery of the desert tortoise and the protection of the West Mojave Desert's wildlife management areas; and d) initial research or analysis to determine impacts of the proposed expansion that may occur outside training areas, such as, but not limited to, the effects of dust and obscurants on the desert tortoise and its habitat.
- Withdrawal of lands identified as necessary for the long-term survival and recovery of the desert tortoise from mining, location, leasing, sale, entry, and other conflicting land uses in order to prevent the loss of the conservation value of the lands by these competing and incompatible uses.

Implementation Success

As of December 2009, the Army implemented a number of the mitigation measures, including:

- Acquisition of 99,170 acres of private land that will ultimately be transitioned to BLM management.
- The entire length of Fort Irwin Road, from I-15 to the boundary of Fort Irwin, has been fenced with tortoise fencing. Additionally, the Army funded installation of 20 miles of desert tortoise fencing along I-15 in an area with a high concentration of tortoises. Also, the entire southern boundary of Fort Irwin (including expansion areas), from its intersection with China Lake in the west to its intersection with Hwy 127 in the east has been fenced with desert tortoise proof fencing to keep translocated tortoises from returning to Fort Irwin.

- Desert tortoise field research, including: 1) desert tortoise dispersion following translocation; 2) reproductive output; 3) maternity and paternity patterns following translocation; 4) microhabitat and burrow use patterns; 5) relative tortoise densities in varying vegetation community situations; 6) development of a habitat model; 7) examination of epidemiology and spread of disease; and 8) examination of long-term stress in translocated tortoises.
- Funding of route closures.
- Purchase and retirement of 323,526 acres of grazing allotments within designated Critical Habitat, including all grazing allotments within the Superior-Cronese Conservation Area.

3.4.5 Assessment of Law Enforcement

Gold Butte-Pakoon Conservation Area

Las Vegas District

BLM law enforcement patrols in the vicinity of the Gold Butte ACEC are conducted from the BLM's Las Vegas Field Office. Law enforcement officers at this location are responsible for patrolling approximately 3.4 million acres of BLM-managed lands in the Las Vegas District, a small part of which is located within the Gold Butte ACEC. From 1990 through 1996, "up to" five law enforcement officers were employed and stationed at Las Vegas Field Office, who primarily patrolled the Red Rock Canyon National Conservation Area. No patrols were conducted within the Gold Butte ACEC during this period, but officers would respond to calls there. Between 1998 and 2007, the number of law enforcement officers employed at the Las Vegas Field Office ranged from eight to 16. MSHCP funds supported the salaries of four of these full-time law enforcement officers between 2003 and 2007. MSHCP funding allowed for targeted patrols within the Gold Butte ACEC at Whitney Pocket, Red Rock Springs, the Lime Canyon Wilderness boundary, and White Rock campground (BLM 2007). From 1997 through 2000 BLM law enforcement officers increased patrols of the Gold Butte vicinity to assist with grazing trespass issues. From 2001 until implementation of the MSHCP, patrols of the Gold Butte ACEC were scaled back to 2-3 patrols per month. Between 2005 and 2007, an average of ten patrol days per month was conducted within the Gold Butte ACEC (BLM 2007). MSHCP funding for the additional law enforcement ended in 2007, but funding for these positions was acquired from the BLM Conservation Initiative through 2011 (personal communication, Erika Schumacher August 14, 2009).

Arizona Strip District

BLM law enforcement patrols in the vicinity of the Gold Butte-Pakoon Critical Habitat area in Arizona are conducted from the BLM's Arizona Strip District Office in St. George, Utah. Currently there are two rangers from this office that patrol the Arizona Strip, including those portions within the Conservation Area. One BLM ranger is assigned to the Grand Canyon-Parashant Monument. Patrols are occasional, and targeted at protecting resources. The most frequent type of law enforcement actions are aimed at illegal OHV use, such as cross-country travel. The ranger that patrols the portion of the Conservation Area in the Monument is also responsible for law enforcement on the Virgin Slope. Patrols in that area are primarily responses to calls regarding illegal OHV use or illegal trash dumping. In addition to the BLM ranger that patrols the Conservation Area, there are four National Park Service rangers that patrol the Monument. The historical level of law enforcement conducted by rangers out of this office over the period between 1990 and 2008 is unknown (personal communication, John Sims October 29, 2010).

Superior-Cronese Conservation Area

BLM law enforcement patrols in the vicinity of the Superior-Cronese Conservation Area are conducted from the BLM's Barstow Field Office in Barstow, California. Law enforcement officers at this location are responsible for patrolling approximately 3.2 million acres of BLM-managed lands in the Barstow region, a small part of which is located within the Superior-Cronese Conservation Area. From 1990 through approximately 2003, four BLM law enforcement officers were stationed at the Barstow Field Office who conducted patrols of BLM-managed lands in the Barstow region. In approximately 2004 and continuing until the present, seven BLM law enforcement officers were stationed at the Barstow Field Office. Patrols in the Superior-Cronese DWMA averaged two days per month, with patrols targeted at areas of high illegal OHV use (personal communication, Mickey Quillman, June 1, 2009).

4. DISCUSSION

4.1 RESEARCH LIMITATIONS

4.1.1 Population Trend Assessments

Our assessment of population trends within the Conservation Areas is limited by the quality of existing datasets and assessments. Because there are almost no published demographic studies for the desert tortoise, researchers conducting population modeling must rely on data primarily available in unpublished government reports (Doak et al. 1994). Many of the sampling surveys (PSP, LDS) resulted in small sample sizes, making it difficult to estimate density. Small datasets are problematic because they often lack the statistical power to identify the likelihood of a significant effect, reducing the ability to detect population declines (Freilich et al. 2005). This becomes a considerable issue when studying declining species or species of concern because of the increased risk of not detecting a population decline in a timely manner (McGarvey 2007). Because tortoises are difficult to detect PSP and LDS data are imprecise and estimates of population density based on these data may be inaccurate. Because of these data limitations, population density estimates derived from LDS data have been shown to exhibit considerable variability in their coefficients of variation (Freilich et al. 2005). High variability in coefficients of variation makes detecting trends in a species with low growth potential particularly difficult (Nussear and Tracy 2007). In the case of the desert tortoise, we run the risk of not recognizing an irreversible population decline simply because statistical approaches for assessing population trends lack sufficient power as a result of low quality or inconsistent data.

Until a more precise, consistently applied method of population monitoring is developed, estimates of desert tortoise population sizes and trends should be interpreted with caution. Because we currently lack the ability to effectively assess the status of desert tortoise populations, any declines or increases in mortality rates observed in the field should be taken seriously and used as a starting point for more focused research. These field observations should be considered an important source of information regarding desert tortoise populations, and should be used to help develop and or refine conservation and management recommendations.

4.1.2 Habitat Modeling

As a rule, habitat models are limited in that they typically only include a subset of the variables required by the species within its habitat. Habitat models most often consider those variables that are easily measured to the exclusion of those variables that may be more difficult to measure. As well, there may be habitat variables that are unknown to science that may have considerable importance to the species. Those

variables that are difficult to measure or difficult to detect may be important factors that limit species populations.

For our habitat models, we used the same criteria in defining suitable habitat for each Conservation Area. However, the variables we considered may not apply equally to each Conservation Area because of the differences between them. The desert tortoise populations at each Conservation Area may differ in their genetic adaptation to site-specific factors, such as latitudinal, floristic, and geological differences. For instance, we observed that desert tortoises within the Gold Butte-Pakoon Conservation Area use caliche cave cover sites at a much greater frequency than is known for tortoises inhabiting the Superior-Cronese Conservation Area. Other differences between these populations are likely real, and are influenced by adaptation to area-specific habitat variables. Thus, our assumption that the variables we chose may be applied to both Conservation Areas may be somewhat flawed, and the habitat models should be interpreted with caution.

4.1.3 Threats Ranking

As a rule, the complexity of a model involves trade-offs between simplicity and accuracy of the equation used to develop it. While added complexity to the equation usually improves the realism of a model, it can make the model difficult to understand and analyze. Developing an equation for a model requires a selection of those factors that are relevant to the real world situation. Therefore, though the equation we developed for determining the effects of threats to desert tortoises and their habitat was based on factors we considered relevant, there may be other, more subtle effects of real-world threats that were not included in our model's equation. Other limitations of the equation include the possibility that there may be correlations between threats that were not properly accounted for in the equation. For instance, we accounted for the interactions of threats with a simple categorization based on the number of interactions between the threats. This approach does not consider threats that may interact or correlate to a greater degree relative to others. For a species like the desert tortoise that is affected by a myriad of threats, producing a model that accurately defines the effects of each threat may be particularly burdensome and problematic. Thus, the threats ranking should be interpreted with caution. We are confident that modeling threats with the HexSim model will allow us to better determine how threats affect desert tortoises and their habitat, as well as how threats interact with each other to produce cumulative effects.

4.1.4 Assessing the Effects of Recovery Actions

Assessing the effects of recovery actions on desert tortoise populations is difficult, as there have been no studies undertaken to determine the effect of implementation of conservation and management measures on desert tortoise population recovery (GAO 2002; Boarman and Sazaki 2006). An additional factor that complicates recovery assessments is the life history of the desert tortoise, which includes long life spans and delayed maturity. As a result, it would likely take decades for scientists to determine whether the implementation of measures has affected population trends. Finally, because desert tortoise populations face numerous threats, the ability to assess the effects of managing for one threat in a particular area may be difficult when other non-managed threats may be influencing population trends.

Furthermore, in the case of assessing the affects of the BLM's implementation of recovery measures, reports that document the monitoring of the actions and their effects are unavailable. There is no public record (outside of reporting required for compliance with the SNPLMA and the MSHCP in Nevada) detailing the implementation of recovery actions by the BLM. The majority of readily available public documents produced by the BLM are NEPA reports and Biological Assessments in support of an action that requires ESA Section 7 consultation. For example, the BLM consulted with the USFWS throughout the 1990s to extend the Interim Livestock Grazing Program until they could assess the effects of grazing

on desert tortoise populations, but there is no record that indicates how the BLM conducted this research, if at all. The effects of the implementation of other management measures cannot be known without their being monitored and reported.

4.2 Evaluation of Conservation Planning and Implementation for the Gold Butte-Pakoon Conservation Area

4.2.1 Threats Prioritization

Livestock Grazing

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Livestock grazing has historically been an important land use in the Conservation Area since the late 1800s, and continues to be an important land use, both legally and illegally. Livestock grazing, as well as grazing by wild (feral) burrows, appears to have played a significant role in shaping tortoise distributions in the Pakoon Basin, where highly impacted areas detected with remote sensing and verified with field reconnaissance are essentially devoid of tortoises, including areas that included NPS plots where tortoises had been observed in the mid 1990s. In other areas where desert scrub remains, soil compaction from grazing livestock has changed the soil characteristics, leading to substantial erosion. Furthermore, we observed a greater abundance and diversity of invasive plants in these areas, and lower abundances and diversity of native annuals and perennials, suggesting that the soil compaction and disturbances are favoring invasive plants over native plants. Since population monitoring of the Pakoon Basin was never accomplished, the timing and occurrence of population declines due to livestock grazing can never be known with any certainty, particularly since the Pakoon Basin has likely been grazed for more than 100 years. However, because of the degree of change attributed to livestock grazing and the absence of tortoises in areas that were occupied in the 1990s, it would appear that livestock grazing may have significantly intensified within the Pakoon Basin since listing of the desert tortoise in 1990, which may have caused tortoises to be driven from highly impacted areas. Anecdotal evidence collected during our field studies in 2009 and 2010 suggest that the actions of a fairly widespread distribution of wild burros are also contributing substantially to habitat degradation in the Pakoon Basin. In particular, we observed burros taking refuge on wash banks in areas of well-developed caliche, which resulted in trampling and blocking of caliche cave entrances, making them unusable as refuges for tortoises. Despite the apparent rarity of desert tortoise in areas highly impacted by grazing, we located small pockets of tortoise populations persist predominantly in relatively small areas that are inaccessible to grazing cattle in the lower Pakoon Basin.

In contrast, grazing appears less intensive on the Virgin Slope in Arizona where grazing allotments are currently being used, as well as on the Virgin Slope and Wechech Basin in Nevada where very low density grazing continues in the form of trespass. These areas support more widespread desert tortoise populations.

How was this threat addressed in the 1994 Recovery Plan?

The threat of grazing by domestic livestock and feral horses and burros was addressed by the following two general measures that were recommended for all DWMAs:

Prohibit domestic livestock grazing

> *Prohibit grazing by feral ("wild") burros and horses*

Though the 1994 Recovery Plan assumed that livestock grazing was a threat primarily because of food competition, our study demonstrates that changes in soils and vegetation communities appear to have a much more detrimental effect on desert tortoise populations. For example, some grazing allotments are grazed on a seasonal basis that excludes livestock from areas during the spring, when tortoises forage on winter annual plants. However, our analyses indicate that the more detrimental effect of livestock grazing is habitat degradation that ultimately (especially in areas that are heavily grazed) may lead to the exclusion of tortoises. Heavily grazed areas are characterized by compacted soils, destroyed biotic soil crusts, high susceptibility to erosion, and changes in annual and perennial plant growth that limit tortoises from inhabiting these areas. This was clearly demonstrated in the Pakoon Basin where we observed that tortoises were largely absent from areas accessible to grazing cattle and more abundant in pockets of habitat that, because of steep terrain, cattle could not access. Large areas that were devoid of tortoises exhibited significant soil compaction and erosion, as well as vegetation characterized by fewer native plants and a greater diversity of invasive plant species. In light of this, the following general measure of the 1994 Recovery Plan – though intended for higher intensity land uses – applies appropriately to livestock and feral burro grazing:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

There was one Specific Management Action in Appendix F of the 1994 Recovery Plan that applies to the threat of livestock grazing within the Gold Butte-Pakoon Conservation Area:

> *Remove livestock grazing or, if desired, establish terms for experimental cattle grazing in experimental management zones (EMZs).*

Because livestock grazing ranked highest in our threats prioritization, the general measures and Specific Management Action recommended in the 1994 Recovery Plan were and still remain appropriate.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

Removal of livestock grazing has largely been accomplished by the Las Vegas District on the Gold Butte ACEC in Nevada with the release of the 1998 LVRMP. Additionally, implementation of the MSHCP and SNPLMA likely facilitated closure of the allotments. Despite these actions, trespass continues to be an issue throughout the ACEC. The Arizona Strip District terminated grazing allotments in portions of the Pakoon Basin, and imposed a seasonal restriction on grazing allotments within the Virgin Slope ACEC with the release of the 1992 ASDRMP. These grazing closures and seasonal restrictions continue under the 2008 NMRMP. Despite the regulations prescribed in these documents, the allotments are still being subjected to fairly substantial grazing by trespassing livestock.

<u>What recommendations should be considered?</u>

In addition to recommending removal of livestock grazing from the DWMAs, including a specific call-out for the Gold Butte-Pakoon DWMA, the 1994 Recovery Plan includes the following recommendations that may be applied to mitigate the threat of grazing:

> *Restore disturbed areas*

Establish environmental education systems and facilities

Enforce regulations

These recommendations could be implemented accordingly:

A habitat restoration plan should be developed for the Pakoon Basin that includes assessing the distribution of areas within the Conservation Area that have been impacted by livestock and feral burro grazing, as well as localized areas associated with grazing infrastructure; application of habitat restoration to areas characterized by compacted soils and degraded vegetation communities, as well as wash banks and caliche caves impacted by burro trampling; and monitoring/reporting of restoration efforts.

Environmental education within local communities, especially those with ties to ranching, may be a method of improving attitudes that contribute to the trespass situations in both Nevada and Arizona.

Termination of grazing allotments should be enforced.

Additionally, we recommend that grazing be eliminated from the Virgin Slope ACEC in Arizona in future management considerations.

Fire

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Through remote sensing techniques, we identified significant areas of change to desert tortoise habitat that were attributed to the second highest ranked threat in our analysis – fire. As with intensive grazing, fires appeared to have had a substantial effect on limiting tortoise distributions within the Conservation Area, particularly within the Pakoon Basin. Plot survey data collected from the upper Pakoon Basin (Fire Treatment Area) coupled with reconnaissance searches in likely habitats throughout the treatment area strongly suggest that large areas that burned (sometimes repeatedly) over the past decade no longer support desert tortoise populations. In areas that were both heavily grazed and burned, type conversion from desert scrub to non-native grassland communities has occurred. These areas, in turn, are more susceptible to fire, highlighting the synergistic nature of these threats. The widespread habitat loss and degradation within the Pakoon Basin that we attribute to fire and livestock grazing would appear to have played a significant role in shaping the very limited tortoise distributions we observed there in 2009 and 2010. Areas that burned recently and extensively in the Nevada portion of the Conservation Area (generally Gold Butte ACEC Part B), are at elevations outside of our habitat model. Though tortoise populations may persist there, densities are likely lower than those populations encountered within the habitat model.

How was this threat addressed in the 1994 Recovery Plan?

Though fire was identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

How has the BLM implemented the Recovery Plan's measures?

Though fire was not addressed in the 1994 Recovery Plan, the BLM has included fire management objectives and guidelines in land management plans, including prescriptions for prioritizing important wildlife habitats. The 1992 ASDRMP prescribed requirements for fire management activities that

included protection of special-status plant and wildlife species. Fires were an issue in the Pakoon Basin in 1995 and again in 2005, for which the BLM pursued fire suppression actions through ESA Section 7 consultations. The 2008 ASRMP included more detailed prescriptions for fire management, particularly with respect to protecting desert tortoise habitat. The 1998 LVRMP identified zones for fire management, including one for desert tortoise Critical Habitat, however no specifics for management in this zone were provided.

<u>What are additional or revised recommendations that should be considered?</u>

Though fire was not addressed in the 1994 Recovery Plan, the USFWS provided two recommendations that may be applied to managing this threat:

Restore disturbed areas

Enforce regulations

These recommendations could be implemented accordingly:

A habitat restoration plan should be developed for the Pakoon Basin that includes assessing the distribution of areas within the Conservation Area that have been impacted by fire; application of habitat restoration to these areas, particularly in areas that may be at risk for vegetation type conversion; and monitoring/reporting of restoration efforts.

Regulations pertaining to activities that could cause wildfires should be enforced, particularly use of OHV off of designated routes. The BLM should prescribe and enforce a rule that prohibits camp fires within ACECs and/or Critical Habitat.

Invasive Plants

<u>How is this threat distributed within the Conservation Area and how has it limited tortoise populations?</u>

Invasive plants, despite not contributing substantially to mortality or habitat degradation, scored high in the threats prioritization due the high number of interactions it shares with other threats, and because of our assumption that invasive plants occur over the entire Conservation Area. During our field studies we observed invasive plants throughout the Treatment Areas, though certain areas appeared to be more severely affected than others. Further research into the differential distributions and abundances of invasive plant species within the Conservation Area may be necessary to determine how this threat affects desert tortoise populations there, and how it may contribute cumulatively with other threats, such as fire and grazing, to degrade desert tortoise habitat.

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

Though invasive plants were identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

This threat is not addressed in the 1992 ASDRMP. The 2008 ASRMP and NMRMP state that invasive annual grasses will be reduced or removed from desert tortoise habitat through the continuation of ongoing implementation of control actions outlined in the Weed Management Area Plan. Within the

Mojave Desert Ecological Zone, vegetation treatments will be implemented to enhance vegetative diversity, restore native plant communities, maintain or increase wildlife habitat, and reduce or eliminate hazardous fuels, with a priority in areas where desert tortoise habitat has been burned and/or converted to invasive annual grass communities.

What are additional or revised recommendations that should be considered?

Though spread of invasive plants was not addressed in the 1994 Recovery Plan, the USFWS provided two recommendations that may be applied to managing this threat:

> *Enforce regulations*

> *Restore disturbed areas*

These recommendations could be implemented accordingly:

For projects or actions that result in ground disturbance, the BLM should enforce the implementation of measures to ensure that invasive plants are not imported into project sites or spread into areas disturbed by the action. These measures should include a requirement for the development of an invasive species prevention plan for actions. The plan should include measures that prevent invasive plant seeds from being imported into the Conservation Area on equipment and machinery, and restoration of disturbed areas.

A habitat restoration plan should be developed for the Conservation Area that includes assessing the distribution of areas that have been impacted by invasive plants; application of habitat restoration to these areas, particularly in areas that may be at risk for vegetation type conversion; and monitoring/and reporting of restoration efforts.

Roads

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

We identified roads as being an important threat (#4) in our threats prioritization analysis for the Gold Butte-Pakoon Conservation Area, though the scope of our field studies did not allow us to determine whether the presence of roads in desert tortoise habitat lead to local population declines. It is possible that the road effect observed in studies conducted in California may not apply similarly to the roads within the Gold Butte-Pakoon Conservation Area. Future research should be directed at determining the responses of local desert tortoise populations to roads there.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified a number of general measures, as well as one Specific Management Action, that may apply to road management. The following general measures outlined in the plan do not specifically address roads, but may be applied to road management within the Conservation Area:

> *Prohibit vehicle activity off of designated roads*

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

Prohibit uncontrolled dogs out of vehicles

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This specific recommendation appears erroneous, and was possibly intended for the Beaver Dam Slope Critical Habitat Unit, which borders these highways:

Construct desert tortoise barrier fencing along Interstate 15 and Highway 91 to protect desert tortoises from vehicle kills, collection, and vandalism.

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This recommendation does not refer to roads specifically, but may be applied to road management:

Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The 1992 ASDRMP and the 2008 ASRMP and NMRMP designated routes on the Arizona portion of the Conservation Area. The 1992 plan did not address transportation, but the 2008 plans contained transportation management plans that described how roads were to be used. Most areas within the Conservation Area were designated Specialized or Primitive TMAs, which support limited travel for a variety of uses, but in a manner or at a level that would not cause "detriment or exclusion of the protection of resources." Major routes within the Arizona portion of the Conservation Area fall into the Backways TMA, a designation that provides access to Specialized and Primitive TMAs, as well as opportunities for interpretive developments and administrative facilities.

The 1998 LVRMP designated routes within Nevada portion of the Conservation Area, and closed several existing routes. Funding from the SNPLMA and MSHCP fees provided opportunities for restoring closed routes.

Signage has been accomplished in portions of Nevada, primarily on the most travelled roads that enter the Conservation Area. Signage has not been implemented in Arizona.

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following recommendations that may be applied to road management:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

The designation of routes and TMAs in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

Routes that act as byways should be patrolled regularly to enforce speed limits and check for appropriate uses and activities within the Conservation Area. Less travelled routes should be patrolled, but less often than the byways.

Closed routes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring closed routes that include monitoring/reporting of restoration efforts.

Additionally, we recommend signage along roads that enter the Conservation Area through Scenic and Littlefield. There are additional opportunities for signage in both Arizona and Nevada, particularly along well-travelled routes such as Gold Butte Backcountry Byway, around Whitney Pocket, and along routes in Backcountry TMAs. Recreationists could be reminded that they are in Critical Habitat for desert tortoises, perhaps accompanied by interpretive signage. We recommend that any additional signage in the Conservation Area be low-statured, no more than 6-ft in height, in order to prevent the signs from being used by ravens for nesting or perching in desert tortoise habitat.

Finally, we recommend that routes be periodically monitored or studied to determine whether they are causing "detriment or exclusion of the protection of resources." Routes that are characterized by wildlife-vehicle strikes (particularly desert tortoise strikes) should be closed.

Climate Change

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Climate change, likely because of the manner in which it may affect future fire regimes in the Conservation Area, scored high in the threats prioritization. Though climate change has probably not yet had an effect on desert tortoise populations, future populations may be at risk, particularly in fire-prone habitats.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan did not address the threat of climate change. Additionally, the 1994 Recovery Plan does not provide general recommendations for management of the DWMAs or Specific Management Actions in Appendix F that could address this threat.

How has the BLM implemented the Recovery Plan's measures?

None of the land management plans address the threat of climate change.

What are additional or revised recommendations that should be considered?

The BLM should encourage research that examines the predicted effects of climate change to Mojave Desert ecosystems in order to prescribe land management actions that do not exacerbate the effects of climate change.

Subsidized Predators

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Our analysis indicates that predation pressure from subsidized predators is strongest on the Virgin Slope adjacent to the communities of Mesquite, Bunkerville, Littlefield, and Scenic. The threat of subsidized predators may have played an important role in causing population declines between 1990 and 2008. Anecdotal field observations suggest that juvenile and young adult tortoises are rare in the Conservation

Area. It's possible that high predation pressure on neonate and juvenile cohorts over the past several years has significantly curtailed the recruitment of adults into the population, resulting in the demographic structure we observed. Two neonate tortoises in our telemetry sample disappeared, presumably when they were carried out of range (intensive searches of their home ranges were negative). We surmise that these individuals, which were sampled from the vicinity of Whitney Pocket, were predated by ravens. The common raven is particularly common throughout the Conservation Area, and has likely been a factor in depressing recruitment rates. Future adult recruitment may be affected as well.

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

The 1994 Recovery Plan includes the following general recommendation that may be applied to management of subsidized predators:

Prohibit uncontrolled dogs out of vehicles

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The 1992 ASDRMP and 1998 LVRMP do not address the threat of subsidized predators. However, through Biological Opinions issued by the USFWS, the BLM has ensured that implemented actions did not contribute to subsidizing predators. The 2008 ASRMP and NMRMP stipulate that any proposed action will be evaluated for its potential to subsidize predators in desert tortoise habitat.

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following recommendations that may be applied to management of subsidized predators:

Enforce regulations

Control use of landfills and sewage ponds by desert tortoise predators

These recommendations could be implemented accordingly:

The BLM should continue to enforce anti-predator attracting measures instituted during the implementation of actions, and monitor their effectiveness.

The BLM should ensure that landfill and pond development is limited to areas at least 5 km from the ACEC and WHA boundaries.

Additionally, we recommend that in addition to controlling dogs outside of vehicles, the BLM should enforce a policy of zero dogs within the Conservation Area. This should include pets brought in by recreationists or hunters, or entering uncontrolled from local communities, as well as feral dogs. The BLM should develop programs to track population parameters and occurrence locations for feral dogs, coyotes, and common ravens.

OHV Use

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

OHV use has become more popular within the Conservation Area over the past 20 years, and recreationists from the region seek out the views and trails there, particularly at Whitney Pocket. We detected change associated with OHV use in the Whitney Pocket vicinity, particularly within washes throughout the Wechech Basin. At all of our survey plots within the Wechech Basin, we detected greater numbers of carcasses than live tortoises – possible evidence of a recent die-off of tortoises in the area. Though there is no evidence to indicate what caused the tortoise deaths, it is possible that increased human use and associated environmental stressors may have contributed at some level. None of the tortoises we observed in the area appeared sick, nor has preliminary antibody testing indicated a response to *Mycoplasma* from these tortoises, suggesting that if disease was responsible for the die-off it no longer appears to be a threat. How human use may have contributed to recent tortoise die-offs may never be understood, but continued monitoring of desert tortoise populations may help in providing answers.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified a number of general measures, as well as one Specific Management Action, that apply or may apply to OHV management. The following general measure was written specifically for OHV use:

> *Prohibit vehicle activity off of designated roads*

The following general measures outlined in the plan do not specifically address OHV use, but may be applied to OHV and recreation management within the Conservation Area:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

> *Prohibit uncontrolled dogs out of vehicles*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This recommendation does not refer to OHV use specifically, but may be applied to OHV and recreation management:

> *Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.*

How has the BLM implemented the Recovery Plan's measures?

The 1992 ASDRMP and the 2008 ASRMP and NMRMP designated routes and limited use areas on the Arizona portion of the Conservation Area. The 1998 LVRMP also designated routes, and limited motorized and mechanized travel to designated routes. The 1998 LVRMP also limited lands within the Conservation Area to non-speed events, with stipulations for the number of events per year and the number of participants per event. Despite these regulations, some OHV users continue illegal practices, as was evidenced in the remote sensing analysis and during the field study.

The Las Vegas District Office has, with funding assistance from the SNPLMA and MSHCP, positioned signs along major entryways to the Conservation Area that mark the ACEC boundaries. Additional

signage is provided along closed trails and in areas that have been restored following habitat degradation from OHV use.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to OHV and recreation management:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

Establish environmental education systems and facilities

These recommendations could be implemented accordingly:

The BLM has already implemented controlled vehicular access to the ACECs and Pakoon WHA through route and limited use area designations.

The ACECs and Pakoon WHA should be patrolled regularly to enforce OHV regulations within the Conservation Area.

Closed trails and washes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities in the region may be a method of improving attitudes of illegal OHV recreationists in both Nevada and Arizona. Interpretive signage may be another method of informing recreationists of the consequences of illegal OHV use.

Additionally, we recommend that tortoise populations in the Whitney Pocket area be continually monitored to determine whether human recreational use of the area is affecting desert tortoise populations negatively there.

Collection and Poaching by Humans

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

The threat of tortoise collection and poaching is difficult to measure within the Conservation Area, but data from other studies suggest that this threat is likely affecting desert tortoise populations there. Since the human behaviors that constitute this threat are difficult to measure, we cannot how they may be impacting desert tortoise populations. We can, however, predict that collection and poaching of tortoises – as well as other human behaviors that contribute to killing tortoises – would likely occur in areas that provide the easiest opportunities for human access within the ACECs and Pakoon WHA, particularly along roads, near urban areas, and in areas frequented by OHV users and recreationists.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following recommendations that may be applied to managing the collecting, poaching, and vandalism of tortoises by humans:

> *Prohibit release of captive or displaced tortoises*
>
> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This recommendation does not refer to collection and poaching specifically, but may be applied to their management:

> *Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.*

How has the BLM implemented the Recovery Plan's measures?

The Las Vegas District Office supports the Desert Tortoise Conservation Center, where displaced and former captive tortoises are held for research and education purposes.

There are no provisions for target shooting in desert tortoise habitat in the 1992 ASDRMP or the 1998 LVRMP. The 2008 ASRMP and NMRMP both contain provisions for modifying rules pertaining to any recreational activity that degrades special-status species habitat or may cause disturbance, injury, or mortality to the species.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to managing collection and poaching of tortoises:

> *Control vehicular access to DWMA*
>
> *Enforce regulations*
>
> *Establish environmental education systems and facilities*

These recommendations could be implemented accordingly:

The BLM has already implemented controlled vehicular access to the ACECs and Pakoon WHA through route and limited use area designations.

The ACECs and Pakoon WHA should be patrolled regularly to enforce regulations pertaining to the collection and poaching of tortoises, as well as those pertaining to hunting and target shooting. Less travelled routes should be patrolled, but less often than the byways.

Environmental education within communities in the region may be a method of informing the public about the illegality of tortoise collecting in both Nevada and Arizona. Interpretive signage may be another method of informing recreationists of the consequences of illegal collection.

Disease

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Anecdotal observations of tortoises exhibiting clinical signs of URTD on the Virgin Slope PSP (Goodlett and Woodman 2003) and large accumulations of carcasses on the Gold Butte PSP between 1986 and 1990 suggesting high mortality rates (Medica 1992), paired with data from neighboring PSPs and LDS surveys throughout the Northeast Mojave Recovery Unit where significant population declines were observed (Walker and Woodman 2002; USFWS 2008b), suggest that populations in the Gold Butte-Pakoon Conservation Area experienced widespread and precipitous die-off due to URTD. Despite the possibility that disease may have played a major role in past population declines in the Gold Butte-Pakoon Conservation Area, our analysis places this threat near the middle of the adjusted score distribution for all threats. All of the tortoises we sampled in the spring of 2010 were negative for *Mycoplasma* antibodies, suggesting that the threat of disease may have diminished within the Conservation Area.

How was this threat addressed in the 1994 Recovery Plan?

Although disease was identified as the most serious threat to desert tortoise populations when the species was listed in 1990, there are no general recommendations for managing the threat of disease within DWMAs, nor is there a Specific Management Action in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA.

How has the BLM implemented the Recovery Plan's measures?

Prior to the current study, there have been no investigations into the occurrence of *Mycoplasma* within the Conservation Area.

What are additional or revised recommendations that should be considered?

The BLM should conduct periodic sampling to determine the disease status of desert tortoise populations within the Conservation Area.

Mineral Extraction

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Historically, mining has been most prevalent on the Nevada side of the Conservation Area, though most mineral extraction activities were located in Gold Butte ACEC. Part B. Mining has been largely absent from the Virgin Slope and Pakoon Basin. Mining has likely only been a factor to local tortoise populations.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that may be applied to mineral management:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

How has the BLM implemented the Recovery Plan's measures?

The 1992 ASDRMP allows mineral exploration and development on a case-by-case basis with a consideration of the cumulative effects on desert tortoise recovery. The 2008 ASRMP allows fluid mineral leasing on the Virgin Slope, but mining activities that cause surface disturbance are not allowed. The 2008 NMRMP does not rule out mineral extraction within the Pakoon WHA, though it requires consideration of special-status species for any surface-disturbing actions. The 1998 LVRMP closed locatable minerals and solid leasables within the Gold Butte ACEC, Part A. Since 2002, the Nevada portion of the Conservation Area has been segregated from mineral entry. The BLM has applied for a 20-year withdrawal from mineral entry and patent for all ACECs in the Conservation Area. Until this proposed action is approved, any mining claims that are not renewed are closed. One mine in Cedar Basin (south of the Gold Butte Townsite ACEC) was closed through this process.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to mineral management:

Enforce regulations

Restore disturbed areas

For mining projects that result in ground disturbance, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

Disturbances caused by mineral extraction activities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Degradation of Air Quality

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Air quality in the Gold Butte-Pakoon Conservation Area is likely only a factor on the Virgin Slope, where nitrogen particles originating from I-15 and the communities of Mesquite, Bunkerville, Littlefield, and Scenic are deposited, contributing to the growth of non-native invasive plants, which displace native forage for desert tortoises and increase susceptibility for fire. Other particles, including fugitive dust, have not likely impacted desert tortoise populations to any great degree.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan did not address the threat of air quality degradation. Additionally, the 1994 Recovery Plan does not provide general recommendations for management of the DWMAs or Specific Management Actions in Appendix F that could address this threat.

How has the BLM implemented the Recovery Plan's measures?

The 2008 ASRMP and NMRMP both address the issue of fugitive dust and its mitigation during the implementation of actions.

What are additional or revised recommendations that should be considered?

The BLM should monitor the effects of fugitive dust produced during implementation of actions, as well as vehicular traffic on unpaved roads, on adjacent vegetation communities.

Urbanization

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Urbanized areas in the vicinity of the Gold Butte-Pakoon Conservation Area are primarily located outside of, but adjacent to, the Conservation Area boundaries. These include the communities of Mesquite, Bunkerville, Littlefield, and Scenic. Though most of these communities are buffered by BLM lands outside of the Conservation Area, Scenic abuts the Conservation Area boundaries. Human populations have grown considerably between 1990 and 2008, particularly in Mesquite. Scenic is a fairly new community. This growth in population and development has likely added stressors and other threats to the adjacent Conservation Area. This may especially be the case where Scenic borders the Conservation Area, where there is no buffer of public lands to 'soften' the urban/wildland interface. The effects of this adjacent urbanization to tortoise populations on the Virgin Slope between 1990 and 2008 are unknown. Our field studies have shown that some of the highest density tortoise populations exist on the lower Virgin Slope just outside of Bunkerville, where the effects of the adjacent community were apparent (trash dumps) despite the buffer of public lands between the Conservation Area boundary and the community.

The Mojave Amendment of the 1992 ASDRMP authorized the BLM to acquire land in-holdings within the ACEC boundaries. Likewise, the SNPLMA and MSHCP allowed for the purchase of land in-holdings within the ACECs. Acquiring land in-holdings would prevent them from being developed.

How was this threat addressed in the 1994 Recovery Plan?

Though the USFWS acknowledged that urbanization was a threat to desert tortoise populations, they provided no general measures or Specific Management Actions in the 1994 Recovery Plan. However, the plan includes the following general recommendations that may be applied to management of the urban/wildland interface:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*
>
> *Prohibit uncontrolled dogs out of vehicles*
>
> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA:

> *Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.*

How has the BLM implemented the Recovery Plan's measures?

The Las Vegas District Office has positioned signs along major entryways to the Conservation Area that mark the ACEC boundaries.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to managing the urban/wildland interface:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

Establish environmental education systems and facilities

These recommendations could be implemented accordingly:

The BLM has already implemented controlled vehicular access to the ACECs and Pakoon WHA through route and limited use area designations.

Routes leading into the Conservation Area from the communities of Mesquite, Bunkerville, Littlefield, and Scenic should be patrolled regularly to enforce speed limits and check for appropriate uses and activities within the Conservation Area.

Surface disturbances at the urban/wildland interface should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities at the urban/wildland interface may be a method of informing the public about the status of the desert tortoise and land designations near their communities.

Additionally, we recommend that the urban/wildland interface at the Scenic/Virgin Slope ACEC boundary be fenced with tortoise-proof fencing to prevent dispersal of tortoises into this quickly developing urbanized area. We further recommend that, where possible, a buffer of BLM-managed lands be maintained between the Conservation Area boundaries and private property in Scenic and other communities that may urbanize in the future, including Mesquite and Bunkerville. This buffer will lower and possibly prevent many of the effects of urbanization from affecting tortoise populations in the Conservation Area. Future land exchanges implemented through the SNPLMA should be directed at securing as large a buffer as possible.

Toxin and Pollutant Deposition

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

We predicted that toxin and pollutant deposition would be limited to areas around mines and along roads and trails leading into the Conservation Area from urbanized areas, so its effects would be primarily confined to local tortoise populations at these locations. Its effects on tortoises in the Conservation Area between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This recommendation does not refer to toxin and pollutant deposition specifically, but may be applied to its management:

> *Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.*

How has the BLM implemented the Recovery Plan's measures?

The Las Vegas District Office has positioned signs along major entryways to the Conservation Area that mark the ACEC boundaries.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of toxin and pollutant deposition:

> *Control vehicular access to DWMA*

> *Enforce regulations*

> *Restore disturbed areas*

These recommendations could be implemented accordingly:

The BLM has already implemented controlled vehicular access to the ACECs and Pakoon WHA through route and limited use area designations.

Routes leading into the Conservation Area from the communities of Mesquite, Bunkerville, Littlefield, and Scenic should be patrolled regularly to check for appropriate uses and activities within the Conservation Area, as well as locate new dump sites.

If discovered, toxin and pollutant dump sites should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Agricultural Practices

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Several hundred acres of agricultural fields are located just outside of the Conservation Area boundaries south and west of Bunkerville, Nevada. One field that appears to be a small fallow pasture is known from within the Pakoon Basin near the Pakoon Tank. The effects of agricultural practices on tortoises in the Conservation Area between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that pertains to agricultural practices:

Prohibit clearing for agriculture

How has the BLM implemented the Recovery Plan's measures?

Agricultural practices are prohibited within ACECs, and have been so within the Virgin River and Pakoon ACECs were designated in 1998 with the Mojave Amendment to the ASDRMP and the Gold Butte ACECs were designated in 1998 with the release of the LVRMP.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendation that may be applied to managing former agricultural fields:

Restore disturbed areas

This recommendation could be implemented accordingly:

Surface disturbances at former agricultural fields should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Litter and Illegal Dumping

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

We predicted that litter and illegal dumping would be limited to areas along roads and trails leading into the Conservation Area from urbanized areas, so its effects would be primarily confined to local tortoise populations at these locations. Its effects on tortoises in the Conservation Area between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of litter and illegal dumps, where target shooting is often a common co-occurrence:

Prohibit discharge of firearms, except for licensed hunting

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Gold Butte-Pakoon DWMA. This recommendation does not refer to litter and illegal dumping specifically, but may be applied to its management:

Sign DWMA boundaries adjacent to communities and settlements (e.g. Littlefield, Arizona, Mesquite, Nevada, etc.) and other areas with conflicting land uses.

How has the BLM implemented the Recovery Plan's measures?

The Las Vegas District Office has positioned signs along major entryways to the Conservation Area that mark the ACEC boundaries.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of litter and illegal dumping:

> *Control vehicular access to DWMA*
>
> *Enforce regulations*
>
> *Restore disturbed areas*
>
> *Establish environmental education systems and facilities*

These recommendations could be implemented accordingly:

The BLM has already implemented controlled vehicular access to the ACECs and Pakoon WHA through route and limited use area designations.

Routes leading into the Conservation Area from the communities of Mesquite, Bunkerville, Littlefield, and Scenic should be patrolled regularly to check for appropriate uses and activities within the Conservation Area, as well as locate new dump sites.

If discovered, illegal dump sites should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities in the region may be a method of informing the public about the illegality and morality of dumping in both Nevada and Arizona.

Utilities

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Utilities are absent from modeled desert tortoise habitat within the ACECs and Pakoon WHA, and only three communications sites occur in Gold Butte ACEC, Part B. Roads accessing the communications sites cross through the ACECs in Nevada. The effects of utility development on tortoises in the Conservation Area between 1990 and 2008 are unknown, though they are likely miniscule.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of utility development:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

How has the BLM implemented the Recovery Plan's measures?

The 1998 ASDRMP Mojave Amendment does not address the development of utilities, but it specifically prohibits or limits activities that would result in vegetation removal. The 1998 LVRMP designated the Gold Butte ACEC, Part A as a right-of-way avoidance area. The 2008 ASRMP does not address the issue

of utility development, but states that the effects of surface-disturbing actions to desert tortoise populations from authorized projects will be "minimized or eliminated." The 2008 NMRMP also does not address utility development, but states that actions that may affect special-status species or adversely modify Critical Habitat, the BLM and NPS will "work cooperatively with the USFWS to resolve or mitigate these impacts through implementation of species-specific conservation measures."

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following general recommendations that may be applied to managing utility development:

Enforce regulations

Restore disturbed areas

These recommendations could be implemented accordingly:

If utility projects that result in ground disturbance are authorized within the Conservation Area, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

Disturbances caused by the development of utilities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Anthropogenic Water Sources

<u>How is this threat distributed within the Conservation Area and how has it limited tortoise populations?</u>

A number of small anthropogenic water sources are scattered throughout the Conservation Area, and are primarily water features associated with livestock grazing operations. The effects of these features *per se* are not likely impacting local desert tortoise populations to any great degree, though their effects on subsidizing desert tortoise predators is substantial (reviewed under Subsidized Predators).

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

Though anthropogenic water sources were identified as a threat in the 1994 Recovery Plan, the plan did not address the threat of anthropogenic water sources in its general recommendations for management of the DWMAs or in Appendix F.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

None of the land management plans address the threat of anthropogenic water sources.

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of anthropogenic water sources:

Restore disturbed areas

Control use of landfills and sewage ponds by desert tortoise predators

Water tanks should be removed from closed grazing allotments, and the disturbances livestock cause in their immediate vicinity should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

The BLM should prohibit the use of open water tanks on open grazing allotments within the Conservation Area.

Railroads

Railroads are not a threat nor are they likely to become a threat within the Conservation Area.

Landfills

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

There are no landfills inside the Conservation Area; therefore the development of landfills *per se* has not affected desert tortoise populations within the Conservation Area, though their effects on subsidizing desert tortoise predators is substantial (reviewed under Subsidized Predators). Our analysis indicates that the Mesquite Landfill may subsidize ravens that forage within the Conservation Area.

How was this threat addressed in the 1994 Recovery Plan?

The threat of landfills was addressed by the following general measure that was recommended for all DWMAs:

Prohibit landfills

How has the BLM implemented the Recovery Plan's measures?

The 1992 ASDRMP authorized the Littlefield Landfill, though it was never implemented. The 1998 Mojave Amendment and the 1998 LVRMP designated the ACECs to protect desert tortoise populations, a designation that prohibits or limits activities that would result in vegetation removal or destruction of desert tortoise habitat. The 2008 ASRMP states that no new landfills will be authorized in the desert tortoise ACECs.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendation that pertains to managing landfills:

Control use of landfills and sewage ponds by desert tortoise predators

This recommendation could be implemented accordingly:

Though landfill development will not likely occur within the Conservation Area, the BLM may authorize landfills in the vicinity of desert tortoise Critical Habitat, including other Critical Habitat Units in the Northeast Mojave Recovery Unit. The BLM should ensure that any landfills that are permitted within ten

miles of desert tortoise Critical Habitat are implemented with controls in place that prevent the subsidizing of common ravens, coyotes, and feral dogs.

Military Activities

Military activities are not a threat within the Conservation Area, and the ACEC designations prohibited military training. The BLM should ensure that military activities continue to be prohibited, per the general measure recommended in the 1994 Recovery Plan:

> *Prohibit habitat-destructive military maneuvers*

Translocation of Tortoise Populations

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Translocation has not been applied within the Conservation Area, though it may be used in the future.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan discusses translocation as possible management tool that should be studied further. The plan provides the following general recommendation that may be applied to the management of desert tortoise translocations:

> *Prohibit collection of biological specimens, except by permit*

How has the BLM implemented the Recovery Plan's measures?

The 2008 ASRMP and NMRMP authorize translocations under the following conditions:

> The BLM can authorize translocations of desert tortoises onto public lands only when all of the following conditions are met: 1) prior authorization from USFWS and AGFD is obtained; 2) the desert tortoise population in the area to which a tortoise(s) is to be moved is depressed; 3) testing of animals to be translocated is conducted to ensure that spread of upper respiratory tract disease or other diseases is not facilitated as a result of translocations; 4) handling of desert tortoises is in compliance with conservation measures; and 5) protocols are followed to ensure that translocated animals have the greatest chance for survival and do not disrupt the behavior of resident animals.

The 1998 LVRMP does not address desert tortoise translocation.

What are additional or revised recommendations that should be considered?

The USFWS (1994a) states that translocation may be considered within the DWMAs once the translocation techniques have been "perfected." Given the outcome of the problematic translocation of desert tortoises in support of the Ft. Irwin Land Expansion Project, the BLM should use extreme caution in considering actions that include the translocation of desert tortoise populations into the Conservation Area. Should a translocation be authorized, the BLM should ensure that the effort is carefully planned, implemented, and monitored.

Drought

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Droughts were not a threat to tortoise populations between 1990 and 2008, but may become a threat in the future if climate change is realized.

How was this threat addressed in the 1994 Recovery Plan?

Though drought was identified as a threat in the 1994 Recovery Plan, the plan did not address the threat of drought in its general recommendations for management of the DWMAs or in Appendix F.

How has the BLM implemented the Recovery Plan's measures?

None of the land management plans address the threat of drought.

What are additional or revised recommendations that should be considered?

The BLM should encourage research that examines the effects of drought to desert tortoise populations in order to prescribe land management actions that do not exacerbate the effects of drought.

4.2.2 Threats Management Prioritization

Threat Management Prioritization

We grouped the prioritized threats into tiers that represented different orders of magnitude between their adjusted scores (S_A). This allowed for further prioritization of threats into levels that would facilitate management decisions. Six groups of threats were distributed among 8 orders of magnitude in the adjusted scores (including scores of zero); for ease we combined scores between 0.000001 and 0.099999 within one tier. The resulting four tiers of threats and their recommended level of management importance are presented in Table 22. The table may be used as a guide for prioritizing management decisions.

Table 22. Threats and Management Priorities for the Gold Butte-Pakoon Conservation Area

Tier	Threats	Management Priority
1	Livestock Grazing Fire Invasive Plants Roads Climate Change Subsidized Predators	**Critical Importance:** Pose a widespread, frequent, and significant threat to desert tortoise populations and should receive immediate, highly focused, and sustained management efforts
2	OHV Use Collection and Poaching by Humans Disease Mineral Extraction Degradation of Air Quality	**High Importance:** Pose an important threat to desert tortoise populations due to their high frequency or wide distribution and should receive sustained management efforts to keep them from reaching critical importance

3	Urbanization Toxin and Pollutant Deposition Agricultural Practices Litter and Illegal Dumping Utilities Anthropogenic Water Sources	**Medium Importance:** Pose a threat to desert tortoise populations infrequently or at a local spatial scale and should receive periodic management efforts to keep them from reaching high importance
4	Railroads Landfills Military Activities Translocation of Tortoise Populations Drought	**Low Importance:** Currently pose a low or negligible threat to desert tortoise populations, but should be monitored for future changes

Additional Recommendations

In addition to prioritizing the management of threats, we recommend the following:

- Areas outside of the habitat model likely support lower density desert tortoise populations. Modeled habitat should receive higher priority for management.
- A more prominent presence of law enforcement with BLM rangers should be applied to the Conservation Area.
- The 1994 Recovery Plan recommends implementing appropriate administration, including a reserve manager, additional staff, and law enforcement personnel. These additional staff should reach out to the public through meeting with various user groups, forming local advisory committees, and developing educational and tourism opportunities. This recommendation is sound and should be pursued at the Arizona Strip and Las Vegas District Offices.
- Desert tortoise populations throughout the Gold Butte-Pakoon Conservation Area should be monitored with periodic surveys of the plots we established for this study. Survey of the plots every five years would, over the long term, allow the BLM to assess whether implementation of land management measures or removal of threats is affecting local desert tortoise populations.
- Outside of the reporting required for the MSHCP and SNPLMA, there is no accounting of the implementation of management measures within the Conservation Area, including those performed for desert tortoise recovery, in the public record. The Arizona Strip District should implement a policy of annual reporting of management measures performed in support of desert tortoise recovery to better track the progress of recovery efforts.

4.3 Evaluation of Conservation Planning and Implementation for the Superior-Cronese Conservation Area

4.3.1 Threats Prioritization

Roads

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Roads are a prominent feature along and within the southern portion of the Conservation Area, with the nexus being the community of Barstow. Most of these roads are associated with the "crossroads" character of Barstow, while others connect communities as far west as Hinkley and as far east as Calico/Yermo. Additionally, significant roads that provide the primary access to Ft. Irwin for personnel (Ft. Irwin Road) and equipment (Manix Trail) cross through the Conservation Area. Some of the roads, including portions of I-15, Ft. Irwin Road, and Hinkley Road, have been fenced with tortoise-proof fencing. Despite this, roads remain an important feature affecting desert tortoise populations within the Conservation Area.

The distribution of roads within and adjacent to the Conservation Area have likely resulted in local depressions or depletions of desert tortoise populations. This threat may also by preventing or restricting genetic exchange between populations within and outside of the Conservation Area. "Mortality sinks" associated with roads comprise a substantial portion of the Conservation Area, and have likely lead to population declines between 1990 and 2008 through tortoise-vehicle strikes and collection of tortoises by humans. Even when tortoise-proof fencing is applied to roadsides to prevent take of tortoises, recent research indicates that population recovery is slow. Beyond the effect of mortality sinks, roads interacted with other threats to a high degree in our analysis. Because declines have been demonstrated for tortoise populations within the West Mojave Recovery Unit, we can assume that roads within and adjacent to the Superior-Cronese Conservation Area have played a major role in desert tortoise population declines there during the period of study.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified a number of general measures, as well as two Specific Management Actions, that may apply to road management. The following general measures outlined in the plan do not specifically address roads, but may be applied to road management within the Conservation Area:

> *Prohibit vehicle activity off of designated roads*
>
> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*
>
> *Prohibit uncontrolled dogs out of vehicles*

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA:

> *Construct barrier fencing along Interstate 15, Ft. Irwin Road, Manix Trail, Superior Lake Road, and the northern border of the DWMA to protect desert tortoises from vehicles, collection, and habitat degradation.*

Construct highway underpasses along Ft. Irwin Road to allow desert tortoise movement and to facilitate genetic exchange throughout this DWMA.

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan does not specifically address roads, but may be applied to road management within the Conservation Area:

Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CSDTMP offers guidelines that include constructing tortoise-proof fences along highways and dirt roads in Category I and II habitats where tortoise-vehicle strikes are known to be common; wildlife crossings under roads should be considered; The BLM designated routes in the original CDCA Plan and its 1999 amendment. They designated routes once again in 2003 following a lawsuit that charged the BLM had bypassed the ESA Section 7 process in designating the 1999 routes. The CDCA contains no specific restrictions on the construction of new roads within the Conservation Area. No new roads were constructed between 1990 and 2008, though Fort Irwin Road was widened and improved, and Manix Trail was widened and oiled – actions implemented by the Department of Defense.

Wildlife crossings were included in the improvement of Ft. Irwin Road, as well as tortoise-proof fencing. Tortoise-proof fencing was applied to the north side of Interstate 15 between Ft. Irwin Road and Afton Canyon Road. This action was funded and implemented by the Department of Defense as a mitigation measure for the translocation of tortoises in support of the Fort Irwin Land Expansion Project. Superior Lake Road and the northern border of the original DWMA were subsumed within the Fort Irwin Land Expansion Project, and the Department of Defense funded and implemented fencing of the boundary between Ft. Irwin and the Conservation Area from China Lake to State Route 127. The County of San Bernardino is currently installing tortoise-proof fencing along Harper Lake Road north of US Highway 58. Manix Trail has not been fenced, but the Department of Defense has implemented measures for avoiding take of tortoises following the issuance of a Biological Opinion by the USFWS. The boundaries of the Conservation Area have not been fenced.

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of roads:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

The designation of routes in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

High-traffic routes should be patrolled regularly to enforce speed limits and check for appropriate uses and activities within the Conservation Area. Less travelled routes should be patrolled, but less often.

Closed routes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring closed routes that include monitoring/reporting of restoration efforts.

Additionally, we recommend signage along roads that enter the Conservation Area along the southern boundary. Currently signs are positioned only on Fossil Bed Road. Other high-traffic routes should be prioritized for signage. Recreationists could be reminded that they are in Critical Habitat for desert tortoises, perhaps accompanied by interpretive signage. We recommend that any additional signage in the Conservation Area be low-statured, no more than 6-ft in height, in order to prevent the signs from being used by ravens for nesting or perching in desert tortoise habitat.

Finally, there are opportunities for additional fencing of Interstate 15 west of Ft. Irwin Road and east of Afton Canyon Road, as well as the southern side of Interstate 15 along the entire length of the Conservation Area boundaries. Additionally, tortoise-proof fencing should be applied to the Yermo Cutoff from Ghost Town Road to Ft. Irwin Road. This two-lane highway is accessed by a substantial amount of high-speed traffic going to Fort Irwin, including semi-trailer trucks, and the probability for tortoise-vehicle strikes is high. The BLM should develop and implement a fencing plan for these roads. The plan should include a design that directs tortoises to wildlife crossings at the underpasses (or provides them along the Yermo Cutoff), and a recommendation for periodic monitoring of the fences to assess maintenance needs.

Climate Change

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Climate change, likely because of the manner in which it may affect future drought severity and frequency in the Conservation Area, scored high in the threats prioritization. Though climate change has probably not yet had an effect on desert tortoise populations, future populations may be at risk, particularly as the region is already prone to droughts.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan did not address the threat of climate change. Additionally, the 1994 Recovery Plan does not provide general recommendations for management of the DWMAs or Specific Management Actions in Appendix F that could address this threat.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP and CDCA Plan do not address the threat of climate change.

What are additional or revised recommendations that should be considered?

The BLM should encourage research that examines the predicted effects of climate change to Mojave Desert ecosystems in order to prescribe land management actions that do not exacerbate the effects of climate change.

Invasive Plants

Invasive plants, despite not contributing substantially to mortality or habitat degradation, scored high in the threats prioritization due the high number of interactions it shares with other threats, and because of our assumption that invasive plants occur over the entire Conservation Area. Further research into the differential distributions and abundances of invasive plant species within the Conservation Area may be

necessary to determine how this threat affects desert tortoise populations there, and how it may contribute cumulatively with other threats, such as roads and utility corridors, to degrade desert tortoise habitat. How invasive plants have affected the distribution and density of desert tortoise populations within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

Though invasive plants were identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP does not address the threat of invasive plants. The Vegetation Element of the CDCA Plan lists among its goals the elimination of harmful plants and maintenance of diversified native plant communities over the proliferation of non-native species. There is no mention of a plan for assessing, controlling, and monitoring for invasive plants, or measures to implement to achieve this goal.

What are additional or revised recommendations that should be considered?

Though spread of invasive plants was not addressed in the 1994 Recovery Plan, the USFWS provided two recommendations that may be applied to managing this threat:

Enforce regulations

Restore disturbed areas

These recommendations could be implemented accordingly:

For projects or actions that result in ground disturbance, the BLM should enforce the implementation of measures to ensure that invasive plants are not imported into project sites or spread into areas disturbed by the action. These measures should include a requirement for the development of an invasive species prevention plan for actions. The plan should include measures that prevent invasive plant seeds from being imported into the Conservation Area on equipment and machinery, and restoration of disturbed areas.

A habitat restoration plan should be developed for the Conservation Area that includes assessing the distribution of areas that have been impacted by invasive plants; application of habitat restoration to these areas, particularly in areas that may be at risk for vegetation type conversion; and monitoring/and reporting of restoration efforts.

Subsidized Predators

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

The presence of urbanized areas and roads adjacent to and within the southern portion of the Conservation Area, along with the agricultural and ranching communities of Hinkley and Harvard within the Conservation Area, provides considerable opportunities for predators to obtain human subsidies. Our analysis indicates that predation pressure from subsidized predators spreads over a considerable portion of the Conservation Area. The threat of subsidized predators may have played an important role in causing population declines between 1990 and 2008. High rates of juvenile tortoise predation by common ravens

and coyotes have been documented at the Fort Irwin Study Site, located within the Conservation Area (M. Tuma, personal observation). It's likely that high predation pressure on neonate and juvenile cohorts over the past 20 years has significantly curtailed the recruitment of adults into the desert tortoise population in the Conservation Area. Future adult recruitment may be affected as well. High rates of predation of adult desert tortoises were observed during translocation of tortoises performed in support of the Fort Irwin Land Expansion Project. Following the drought of 2006-2007 and the subsequent crash of prey (black-tailed jackrabbit and white-tailed antelope squirrel) populations, coyotes turned to preying on desert tortoises, and were responsible for inflicting high rates of predation on translocated and resident desert tortoises (Esque et al. 2009; Esque et al. 2010). Other studies have documented similar predation by canids during periods of drought (Peterson 1994; Karl 2002b). Prior to the 2006-2007 drought, we detected more extensive and severe drought events in the Conservation Area during our period of study: one between 1992 and 1996, and another between 2001 and 2004. These events were likely accompanied by intensive and widespread predation pressure by coyotes on desert tortoise populations within the Conservation Area.

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

The 1994 Recovery Plan identified one general measure and one Specific Management Action that may apply to the management of subsidized predators. The following general recommendation is provided in the plan:

> *Prohibit uncontrolled dogs out of vehicles*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA:

Reduce raven populations in the DWMA to lessen mortality of small desert tortoises to a point where recruitment into the adult cohort can occur at as rapid a rate as possible.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CSDTMP recommends that a raven management plan be developed and implemented, as well as studies directed at determining whether water guzzlers subsidize canid predation on desert tortoise. Sporadic removals of common raven nests have been accomplished in recent years, but a consistent, organized approach to raven management has not yet been developed. Acting as lead agency in support of NEPA review, the USFWS released in 2008 a Finding of No Significant Impact and an Environmental Assessment analyzing the effects of implementation of a raven management plan that would include public outreach and education, reducing human subsidies for the common raven, and limited removal of ravens in designated areas. Later in 2008 the Desert Managers Group established the Raven Management Working Group to carry out the preferred alternative outlined in the Environmental Assessment. As a partner in the Desert Managers Group, the BLM participated in this process. The Raven Management Working Group is currently collecting data in support of developing a raven nest database until the raven management plan is developed. The threat of coyote predation has not yet been addressed. Following the drought of 2006-2007, coyotes turned to preying on tortoises when the black jackrabbit population crashed. This issue became problematic for the Department of Defense during the 2007 desert tortoise translocations performed in support of the Fort Irwin Land Expansion Project. Short-term measures (removal of coyotes with a sharp-shooter) were implemented within several of the release plots on BLM lands in late 2007.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to management of subsidized predators:

Enforce regulations

Control use of landfills and sewage ponds by desert tortoise predators

These recommendations could be implemented accordingly:

The BLM should continue to enforce anti-predator attracting measures instituted during the implementation of actions, and monitor their effectiveness.

The BLM should ensure that landfill and pond development is limited to areas at least 5 km from the ACEC and WHA boundaries.

Additionally, we recommend the following measures:

The BLM should enforce a policy of zero dogs within the Conservation Area. This should include pets brought in by recreationists or hunters, or entering uncontrolled from local communities, as well as feral dogs.

The BLM should develop programs to track population parameters and occurrence locations for feral dogs, coyotes, and common ravens.

Long-term plans for coyote control measures should be planned for future droughts.

Urbanization

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Urbanization within and adjacent to the Superior-Cronese Conservation Area has affected desert tortoise habitat fairly substantially, and has likely influenced the distribution and density of adjacent desert tortoise populations. The Conservation Area contains a substantial amount of land in-holdings, and three areas of these in-holdings include parcels that have been developed. These include ranching developments that include numerous homesteads north of Hinkley, agricultural developments that include numerous homesteads north of Harvard, and several ranches with homesteads west of Coyote Dry Lake. In addition, urbanization associated with Barstow either abuts or slightly overlaps the Conservation Area boundaries at several locations. Tortoise populations in the immediate vicinity of these developed areas have likely been extirpated prior to the listing of the desert tortoise. This may be particularly the case for the developments north of Hinkley, where livestock grazing on adjacent properties has likely been intense. Without field surveys and studies of these areas, the effects of this urbanization to tortoise populations between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

Though the USFWS acknowledged that urbanization was a threat to desert tortoise populations, they provided no general measures or Specific Management Actions in the 1994 Recovery Plan. However, the plan includes the following general recommendations that may be applied to management of the urban/wildland interface:

Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises

Prohibit uncontrolled dogs out of vehicles

Prohibit discharge of firearms, except for licensed hunting

The following Specific Management Actions provided in Appendix F of the 1994 Recovery Plan do not specifically address urbanization, but may be applied to managing the urban/wildland interface at the Conservation Area boundary:

Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.

How has the BLM implemented the Recovery Plan's measures?

Urbanization of BLM-managed lands would be considered an inappropriate land use.

In early 2001, the BLM implemented an interim closure of all shooting activities except for hunting and target practice (at printed paper targets) within the Superior-Cronese Conservation Area.

The boundaries of the Conservation Area have not been fenced. Signage has been implemented along Fossil Bed Road only. There are currently no restrictions for dogs within the Conservation Area.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to managing the urban/wildland interface:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

Establish environmental education systems and facilities

The designation of routes in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

Roads leading into the Conservation Area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the Conservation Area.

Surface disturbances at the urban/wildland interface should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities at the urban/wildland interface may be a method of informing the public about the status of the desert tortoise and land designations near their communities.

Additionally, we recommend that the urban/wildland interface between Hinkley and Yermo be fenced with tortoise-proof fencing to prevent dispersal of tortoises into the urbanized area along the US Hwy 58 and I-15 corridor.

Finally, as the Superior-Cronese Conservation Area is fraught with land in-holdings, we recommend that the BLM prioritize their acquisition to prevent them from becoming urbanized. Priority should be given to those in-holdings that are least impacted by disturbances or other threats.

Drought

<u>How is this threat distributed within the Conservation Area and how has it limited tortoise populations?</u>

Droughts are a common feature within the western Mojave Desert. We detected three summer droughts between 1990 and 2008: one between 1992 and 1996, one between 2001 and 2004, and one between 2006 and 2007. Summer droughts are likely an important contributor to desert tortoise mortality, as tortoise survivorship is enhanced when they're able to drink during summer monsoons. Droughts act synergistically with predation by subsidized predators, as was documented during the drought of 2006-2007. This drought caused a crash of prey (black-tailed jackrabbit and white-tailed antelope squirrel) populations, and coyotes turned to preying on desert tortoises. This increased predation pressure on desert tortoises was documented at the Fort Irwin Study Site, as well as other studies in the western Mojave Desert (Peterson 1994; Karl 2002b; Esque et al. 2009; Esque et al. 2010). Other predators may turn to preying on desert tortoise during periods of drought. Previous droughts likely had the same effect on desert tortoise populations within the Conservation Area. Therefore, we conclude that droughts were likely a major source of tortoise mortality and population decline between 1990 and 2008 had a substantial impact on desert tortoise populations. Droughts may become a greater threat in the future if climate change is realized.

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

Though drought was identified as a threat in the 1994 Recovery Plan, the plan did not address the threat of drought in its general recommendations for management of the DWMAs or in Appendix F.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CSDTMP and CDCA Plan do not address the threat of drought.

<u>What are additional or revised recommendations that should be considered?</u>

The BLM should encourage research that examines the effects of drought to desert tortoise populations in order to prescribe land management actions that do not exacerbate the effects of drought. The WEMO contains measures to be implemented during periods of drought that should be implemented during drought periods, whether the WEMO is approved or not. The proposed measures in the WEMO include the following:

- During periods of prolonged drought (lasting three or more years), the BLM would consider emergency route closures (generally referred to as "quarantine areas") in areas supporting higher densities of desert tortoises. Routes within washes, in particular, should be closed as tortoises likely inhabit these features at higher frequencies during drought periods.

- During periods of drought, the BLM would implement a feral dog control program designed to eliminate the synergistic effects of drought and subsidized predators.

Collection and Poaching by Humans

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

The threat of tortoise collection and poaching is difficult to measure within the Conservation Area, but data from other studies suggest that this threat is likely affecting desert tortoise populations there. Since the human behaviors that constitute this threat are difficult to measure, we cannot how they may be impacting desert tortoise populations. We can, however, predict that collection and poaching of tortoises – as well as other human behaviors that contribute to killing tortoises – would likely occur in areas that provide the easiest opportunities for human access within the Conservation Area, particularly along roads, near urban areas, and in areas frequented by OHV users and recreationists. How the pressures of collecting, poaching, and vandalism have affected the distribution and density of desert tortoise populations within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes two general recommendations and three Specific Management Actions that apply to managing the collection and poaching of tortoises by humans. The plan includes the following general recommendations:

Prohibit release of captive or displaced tortoises

Prohibit discharge of firearms, except for licensed hunting

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA pertains specifically to the collection of tortoises:

Establish a drop-off site for unwanted captive desert tortoises at BLM's Barstow Way Station. Develop programs to make unwanted captives available for research and educational purposes.

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to collection and poaching specifically, but may be applied to their management:

Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.

Finally, the USFWS recommended that vandalism and collection of wild desert tortoises and releasing of captive tortoises be immediately halted within the Superior-Cronese DWMA.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP provides guidelines for dealing with captured or captive desert tortoises, including the return of recently captured tortoises to their point of capture, encouraging adoptions of long-term captive or captive raised tortoises, and prohibiting the release of long-term captives. There are no measures that would reduce the take of tortoises through collecting, poaching, or vandalism within the CDCA Plan. The CSDTMP also recommends that shooting be prohibited during the desert tortoise activity season. In early 2001, an interim closure to all shooting except hunting and target practice (at printed paper targets) was implemented within the Conservation Area.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to managing collection and poaching of tortoises:

Control vehicular access to DWMA

Enforce regulations

Establish environmental education systems and facilities

The designation of routes in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

The Conservation Area should be patrolled regularly to enforce regulations pertaining to the collection and poaching of tortoises, as well as those pertaining to hunting and target shooting.

Environmental education within communities in the region may be a method of informing the public about the illegality of tortoise collecting. Interpretive signage may be another method of informing recreationists of the consequences of illegal collection.

Translocation of Tortoise Populations

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Translocation was first implemented within the Conservation Area in 2007 with the release of more than 600 tortoises that were removed from the Southern Expansion Area in support of the Fort Irwin Land Expansion Project. The tortoises were released into areas that supported populations of resident tortoises. This likely resulted in the disruption of dominance hierarchies and increased competition for cover sites and mates with the resident populations, possibly putting them at risk. Additionally, the translocation was likely stressful for translocated tortoises, and to a lesser degree, the resident tortoises. Increased stress among these populations could possibly lead to higher incidence of URTD. Continued monitoring of the translocated and resident tortoises will help determine how these populations will ultimately be affected.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan discusses translocation as possible management tool that should be studied further. The plan provides the following general recommendation that may be applied to the management of desert tortoise translocations:

> *Prohibit collection of biological specimens, except by permit*

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP stipulates that 1) desert tortoise translocations and reintroductions be conducted under experimental controls until adequate information is available to ensure their success; and 2) desert tortoises will only be translocated to areas containing suitable habitat that supports few or no tortoises. The CDCA Plan does not address the threat of conducting translocations of desert tortoise populations.

What are additional or revised recommendations that should be considered?

The USFWS (1994a) states that translocation may be considered within the DWMAs once the translocation techniques have been "perfected." Given the outcome of the problematic translocation of desert tortoises in support of the Ft. Irwin Land Expansion Project, the BLM should use extreme caution in considering any additional actions that include the translocation of desert tortoise populations into the Conservation Area. Should a translocation be authorized, the BLM should ensure that the effort is carefully planned, implemented, and monitored.

Agricultural Practices

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Agricultural practices are conducted within the Conservation Area in the vicinity of Hinkley and Harvard. Tortoise populations in the immediate vicinity of these areas supporting agricultural activity have likely been extirpated prior to the listing of the desert tortoise. The effect of continued agricultural practices to desert tortoise populations in the vicinity of these locations between 1990 and 2008 is unknown.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that pertains to agricultural practices:

> *Prohibit clearing for agriculture*

How has the BLM implemented the Recovery Plan's measures?

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. Agricultural practices are prohibited under the CDCA.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendation that may be applied to managing former agricultural fields:

Restore disturbed areas

This recommendation could be implemented accordingly:

Surface disturbances at former agricultural fields should be restored if land in-holdings are acquired in the future. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

OHV Use

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

OHV use has become more popular within the Conservation Area over the past 20 years, and recreationists from the region utilize trails there. We detected change associated with OHV use primarily in the central portion of the Conservation Area west of the Calico Mountains in the vicinity of the Mud Hills and extending southwestward toward Rainbow Basin and Owl Canyon. The OHV use appears to have impacted areas within the Coolgardie Mesa ACEC, and washes extending to the southwest of the ACEC. Other portions of the Conservation Area likely receive pressure from OHV use, particularly washes extending from designated routes. How OHV use has affected the distribution and density of desert tortoise populations within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified a number of general measures, as well as one Specific Management Action, that apply or may apply to OHV management. The following general measure was written specifically for OHV use:

Prohibit vehicle activity off of designated roads

The following general measures outlined in the plan do not specifically address OHV use, but may be applied to OHV and recreation management within the Conservation Area:

Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises

Prohibit uncontrolled dogs out of vehicles

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to OHV use specifically, but may be applied to their management:

Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.

Finally, the USFWS recommended that illegal OHV use be immediately halted within the Superior-Cronese DWMA.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CSDTMP recommends that vehicle route designations in desert tortoise habitat be reexamined to minimize conflicts with desert tortoises; that competitive events be restricted to existing open play areas; the prohibition of additional open play areas in Category I and II habitats and the fencing of any new open play areas that are adjacent to Category I and II habitats;

In 1994, Congress designated 53,700 acres of Wilderness Areas in the Conservation Area, where OHV use and other vehicular travel is prohibited.

Thirty closed routes in the western portion of the Conservation Area were rehabilitated and restored by 2002 (Redlands Institute 1992).

<u>What are additional or revised recommendations that should be considered?</u>

The 1994 Recovery Plan includes the following recommendations that may be applied to OHV and recreation management:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

Establish environmental education systems and facilities

The designation of routes and limited use areas in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

The Conservation Area should be patrolled regularly to enforce OHV regulations.

Closed trails and washes should be restored and monitored to ensure that they are not being used. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities in the region may be a method of improving attitudes of illegal OHV recreationists. Interpretive signage may be another method of informing recreationists of the consequences of illegal OHV use.

Disease

<u>How is this threat distributed within the Conservation Area and how has it limited tortoise populations?</u>

Upper Respiratory Tract Disease, caused by *Mycoplasma* sp., has been implicated as a major cause of desert tortoise declines in the western Mojave Desert since the 1980s when precipitous die-offs were noted. While other threats such as drought might also explain precipitous population declines, URTD should still be viewed and managed as an important cause of mortality in desert tortoises. The threat of disease within and adjacent to the Conservation Area appears to be associated with urban developments,

office buildings, paved roads, and military use areas (Berry et al. 2006; Mack and Berry 2009). Therefore, we can assume that between 1990 and 2008, desert tortoise populations in the vicinity of these features likely experienced increased mortality from URTD. We may never fully understand how disease affected tortoise populations during this period of study, but ongoing and future research into the environmental factors that cause higher incidence of URTD may allow us to predict with better accuracy how populations responded to disease in the past.

How was this threat addressed in the 1994 Recovery Plan?

There is there one Specific Management Action in Appendix F of the 1994 Recovery Plan pertaining to the management of disease within the Superior-Cronese DWMA. The USFWS recommended it based upon the best scientific knowledge at the time, though in recent years the threat of disease is better understood and generally considered to be less dire than previously thought. In addition, implementation of this recommendation would restrict gene flow between the Conservation Area and the adjacent Fremont-Cramer Critical Habitat Unit, causing more serious harm. For these reasons, the USFWS has likely abandoned it, and the BLM should not consider it:

> *Along the boundary with the Fremont-Kramer DWMA, a double row of desert tortoise barrier fencing may be necessary to prevent the spread of URTD into the Superior-Cronese DWMA.*

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP and CDCA Plan do not address the threat of disease.

What are additional or revised recommendations that should be considered?

The BLM should participate in efforts to periodically sample desert tortoise populations within the Conservation Area to determine their disease status.

Mineral Extraction

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Mining has been a prevalent land use within the Conservation Area, and has likely only been a factor affecting local desert tortoise populations. How mineral extraction activities have affected the distribution and density of desert tortoise populations within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified one general measure and as one Specific Management Action that may be applied to mineral management. The plan provided the following general measure:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. This recommendation does not refer to mineral management specifically, but may be applied to its management:

Initiate cleanup of surface toxic chemicals.

How has the BLM implemented the Recovery Plan's measures?

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan limits disturbance of mining activities to less than five acres for areas designated as Class C and L, as well as in ACECs, and requires a plan of operation that considers potential impacts and provides measures to avoid impacts to sensitive resources such as desert tortoises.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to mineral management:

Enforce regulations

Restore disturbed areas

For mining projects that result in ground disturbance, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

Disturbances caused by mineral extraction activities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts. Additionally, we recommend that the plan includes provisions for evaluating mines sites for the presence and clean-up of toxins.

Degradation of Air Quality

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Air quality in the Superior-Cronese Conservation Area is likely a factor along the southern portion, where nitrogen particles originating from I-15, US Highway 58, and the communities between Hinkley and Harvard are deposited, contributing to the growth of non-native invasive plants, which displace native forage for desert tortoises and increase susceptibility for fire. Other particles, including fugitive dust, are likely impacting vegetation communities along unpaved roads and routes, as well as adjacent to project sites. Air pollution originating from the Los Angeles Basin likely affects biological resources within the Conservation Area, too. How degraded air quality has affected the distribution and density of desert tortoise populations within the Conservation Area between 1990 and 2008 is not known.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan did not address the threat of air quality degradation. Additionally, the 1994 Recovery Plan does not provide general recommendations for management of the DWMAs or Specific Management Actions in Appendix F that could address this threat.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP and CDCA Plan do not address the threat of degradation of air quality.

What are additional or revised recommendations that should be considered?

The BLM should monitor the effects of fugitive dust produced during implementation of actions, as well as vehicular traffic on unpaved roads, on adjacent vegetation communities.

Railroads

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

The Burlington Northern Santa Fe railroad crosses through the southern portion of the Superior-Cronese Conservation area. The railroad alignment may affect desert tortoise populations in the southwestern portion of the Conservation Area west of Hinkley, as well as populations along the southeastern border of the Conservation Area, from Yermo to the west side of Harvard, and from the east side of Harvard to the sharp eastward turn just south of the Afton Canyon Road exit off of Interstate 15. Tortoises attempting to cross the railroad during dispersal movements may become caught between the tracks, causing them to overheat and die or be crushed by trains. How railroad barriers have affected the distribution, density, and genetic exchange of desert tortoise populations within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

Though the 1994 Recovery Plan does not address managing existing rail alignments, it includes the following general recommendation that may be applied to the management of rail development:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP offers no guidelines for the management of railroads. The CDCA Plan recommends the following measures pertaining to rail management:

- Class C: No new railroads and trams will be allowed. Existing railroads and trams may be operated and maintained subject to non-impairment of wilderness values.
- Class L: Railroads and trams may be allowed to serve authorized uses if no other viable alternative is possible.
- Classes M and I: Railroads and trams may be allowed.

What are additional or revised recommendations that should be considered?

The CSDTMP recommended the installation of tortoise-proof fences in Category I and II habitat areas along a number of linear features, including highways, roads, canals, and aqueducts, but neglected rail alignments. We recommend that this measure be applied to railroads within the Conservation Area. The BLM should develop and implement a fencing plan for the railroad alignment between the outskirts of Hinkley and US Highway 395; between Yermo and the west side of Harvard; and between the east side of Harvard and the sharp eastward turn just south of the Afton Canyon Road exit off of Interstate 15. The plan should include a design that directs tortoises to wildlife crossings at the underpasses located along this portion of the rail alignment, and a recommendation for periodic monitoring of the fence to assess maintenance needs.

Toxin and Pollutant Deposition

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

We predicted that toxin and pollutant deposition would be limited to areas around mines and along roads and trails leading into the Conservation Area from urbanized areas, so its effects would be primarily confined to local tortoise populations at these locations. Its effects on tortoises in the Conservation Area between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan pertains to the management of toxin and pollutant deposition within the Superior-Cronese DWMA:

Initiate cleanup of surface toxic chemicals.

The following Specific Management Action was provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. This recommendation does not refer to the management of toxin and pollutant deposition specifically, but may be applied to its management:

Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP and CDCA Plan do not address the threat of toxins and pollutants.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of toxin and pollutant deposition:

Control vehicular access to DWMA

Enforce regulations

Restore disturbed areas

The designation of routes in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

Roads leading into the Conservation Area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the Conservation Area, as well as locate new dump sites.

If discovered, toxin and pollutant dump sites should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Military Activities

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Military activities within the Conservation Area include: 1) the Cuddleback Lake Gunnery Range situated on a land in-holding in the northwestern portion of the Conservation Area; 2) the Superior Valley Gunnery Range that straddles the northern boundary of the Conservation Area; and 3) Manix Trail, which crosses the eastern portion of the Conservation Area. The gunnery ranges do not likely contribute to desert tortoise mortality, and habitat degradation is localized. Manix Trail has likely had a relatively larger impact on desert tortoise populations between 1990 and 2008, as tortoise-vehicle strikes have likely occurred, possibly causing local depressions or depletions of desert tortoise populations. Additionally, the oils used to surface the trail may be contributing to the introduction of toxins into adjacent habitat. The manner in which military activities have affected the distribution and density of desert tortoise populations and degradation of habitat within the Conservation Area between 1990 and 2008 is not understood.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan identified one general measure and as one Specific Management Action that may be applied to the management of military activities. The plan provided the following general measure:

Prohibit habitat-destructive military maneuvers

The following Specific Management Action provided in Appendix F of the 1994 Recovery Plan pertains to the management of military activities within the Superior-Cronese DWMA:

Initiate cleanup of surface toxic chemicals and unexploded ordinance.

How has the BLM implemented the Recovery Plan's measures?

The CSDTMP and CDCA Plan do not address the threat of military activities.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following recommendations that may be applied to the management of military activities:

Enforce regulations

Restore disturbed areas

The BLM should coordinate with the Department of Defense to track the implementation of measures to ensure that desert tortoises are not killed by military convoys accessing Fort Irwin along Manix Trail. Reporting should be included in this coordination.

If discovered, areas containing unexploded ordnance should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of clean-up and restoration efforts.

Utilities

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

The most prominent utility features within the Conservation Area are electrical transmission lines, gas pipelines, and other subsurface linear utilities such as fiber-optic lines. These features are particularly pronounced in the southern portion of the Conservation Area, where several linear utility corridors are situated. Electrical transmission lines provide perching and nesting structures (on towers); in providing these subsidies to the common raven, the presence of the transmission lines within the Conservation Area has likely resulted in increased predation pressure on juvenile desert tortoises within several kilometers of the alignments. Activities associated with the construction and maintenance of gas pipelines are known to cause high rates of desert tortoise mortality (Olson 1996). Therefore, utilities within the Conservation Area have directly and indirectly contributed to desert tortoise mortality between 1990 and 2008.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of utility development:

> *Prohibit any surface disturbance that diminishes the capacity of the land to support desert tortoises*

How has the BLM implemented the Recovery Plan's measures?

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan addresses utility development in the Energy Production and Utility Corridors Element. Utility corridors will be managed under this element in a manner that combines rights-of-way for linear utilities, and avoids sensitive resources.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to managing utility development:

> *Enforce regulations*

> *Restore disturbed areas*

These recommendations could be implemented accordingly:

If utility projects that result in ground disturbance are authorized within the Conservation Area, the BLM should enforce the implementation of measures to ensure that desert tortoises and their habitat are not impacted.

Disturbances caused by the development of utilities should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Additionally, we recommend that existing utility corridors be assessed for the presence and abundance of invasive plants, which are a common character of these features. The spread of invasive plants along these

corridors should be considered a major threat to habitat quality in adjacent areas occupied by desert tortoises, and efforts should be implemented to reduce or eliminate alien plants from the corridors.

Finally, plans developed for gas pipeline construction and maintenance activities should include more robust mitigation measures to prevent take of desert tortoise.

Litter and Illegal Dumping

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

We predicted that litter and illegal dumping would be limited to areas along roads and trails leading into the Conservation Area from urbanized areas, so its effects would be primarily confined to local tortoise populations at these locations. Its effects on tortoises in the Conservation Area between 1990 and 2008 are unknown.

How was this threat addressed in the 1994 Recovery Plan?

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of litter and illegal dumps, where target shooting is often a common co-occurrence:

> *Prohibit discharge of firearms, except for licensed hunting*

The following Specific Management Actions were provided in Appendix F of the 1994 Recovery Plan for the Superior-Cronese DWMA. These recommendations do not refer to litter and illegal dumping specifically, but may be applied to its management:

> *Sign DWMA boundaries adjacent to communities and settlements including Barstow, small settlements north of Barstow, and other areas with conflicting uses.*
>
> *Fence the periphery of the DWMA as needed to enforce regulations and protect desert tortoises from human impacts.*

How has the BLM implemented the Recovery Plan's measures?

In early 2001, the BLM implemented an interim closure of all shooting activities except for hunting and target practice (at printed paper targets) within the Superior-Cronese Conservation Area.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendations that may be applied to the management of litter and illegal dumping:

> *Control vehicular access to DWMA*
>
> *Enforce regulations*
>
> *Restore disturbed areas*
>
> *Establish environmental education systems and facilities*

The designation of routes in the Conservation Area has fulfilled the first of these recommendations. The other recommendations could be implemented accordingly:

Roads leading into the Conservation Area from the communities of Hinkley, Barstow, Yermo, Toomey, Harvard, Afton, and Cronese Valley should be patrolled regularly to check for appropriate uses and activities within the Conservation Area, as well as locate new dump sites.

If discovered, illegal dump sites should be restored. Plans should be developed for restoring these areas that include monitoring/reporting of restoration efforts.

Environmental education within communities in the region may be a method of informing the public about the illegality and morality of dumping.

Livestock Grazing

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Livestock grazing has changed dramatically within the Conservation Area. In 1990 when the desert tortoise was listed, grazing allotments were distributed across large portions of the Conservation Area. As the USFWS was preparing to issue the 1994 Recovery Plan and the designation of Critical Habitat, the BLM initiated Section 7 consultation allow continued grazing on allotments in habitat occupied by desert tortoises and in Critical Habitat. Several allotments were closed to sheep grazing, and seasonal cattle grazing practices were allowed to continue under the Interim Livestock Grazing Program until the BLM could assess the effects of livestock grazing on desert tortoises and their habitat. This program was extended until 1999 for allotments in Critical Habitat. Grazing allotments were finally terminated between 2005 and 2009 as part of the mitigation measures prescribed for the Fort Irwin Land Expansion Project. Desert tortoise populations were likely affected by livestock grazing for the majority of the period of study (1990-2008), and livestock grazing may have lead to population declines. Since this threat was removed, desert tortoise populations are no longer directly affected by grazing, though indirect effects of livestock grazing through habitat degradation will linger for years to come.

How was this threat addressed in the 1994 Recovery Plan?

The threat of grazing by domestic livestock and feral horses and burros was addressed by the following two general measures that were recommended for all DWMAs:

Prohibit domestic livestock grazing

Prohibit grazing by feral ("wild") burros and horses

There was one Specific Management Action in Appendix F of the 1994 Recovery Plan that applies to the threat of livestock grazing within the Superior-Cronese Conservation Area:

Remove livestock grazing or, if desired, establish terms for experimental cattle grazing in experimental management zones (EMZs).

Finally, the USFWS recommended the immediate withdrawal of livestock grazing from the Superior-Cronese DWMA.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CSDTMP recommends that sheep grazing in Category I and II habitats be reevaluated. There are no public documents that detail the research that was to be undertaken by the BLM to assess the effects of livestock grazing on desert tortoises and their habitat. Removal of grazing allotments was accomplished by 2006 as a mitigation measure implemented in support of the Ft. Irwin Land Expansion Project.

Between 1981 and 2001, 4,514 burros and 1 horse were removed from the Slate Range Herd Area, which ranged over a small portion of the Superior-Cronese Conservation Area. The target population of 0 for the Herd Area has not yet been achieved; in 2003 the estimated population was 70.

<u>What recommendations should be considered?</u>

In addition to recommending removal of livestock grazing from the DWMAs, including a specific call-out for the Superior-Cronese DWMA, the 1994 Recovery Plan includes the following recommendation that may be applied to areas that were formerly grazed within the Conservation Area:

> *Restore disturbed areas*

This recommendation could be implemented accordingly:

A habitat restoration plan should be developed that includes assessing the distribution of areas within the Conservation Area that have been impacted by livestock and feral burro grazing, as well as localized areas associated with grazing infrastructure; application of habitat restoration to areas characterized by compacted soils and degraded vegetation communities; and monitoring/reporting of restoration efforts.

Fire

<u>How is this threat distributed within the Conservation Area and how has it limited tortoise populations?</u>

Fire has historically been a minor threat within the Conservation Area, and has not likely impacted desert tortoises to any great degree. However, should invasive plants become more abundant and widespread, fire management may become a higher priority.

<u>How was this threat addressed in the 1994 Recovery Plan?</u>

Though fire was identified as a threat in the 1994 Recovery Plan, the plan did not address this threat in its general recommendations for management of the DWMAs or in Appendix F.

<u>How has the BLM implemented the Recovery Plan's measures?</u>

The CDCA Plan states that use of fire suppression activities are to be performed per requirements of fire management plans.

<u>What are additional or revised recommendations that should be considered?</u>

Though fire was not addressed in the 1994 Recovery Plan, the USFWS provided the following recommendation that may be applied to managing this threat:

Enforce regulations

This recommendation could be implemented accordingly:

Regulations pertaining to activities that could cause wildfires should be enforced, particularly use of OHV off of designated routes. The BLM should prescribe and enforce a rule that limits the use of camp fires within the Conservation Area.

Anthropogenic Water Sources

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

Anthropogenic water sources are common within and adjacent to the Conservation Area. Nearly all of the water sources are associated with urban developments, agricultural operations, and ranching operations. Those located within the Conservation Area are located on in-holdings. The effects of these features *per se* are not likely impacting local desert tortoise populations to any great degree, though their effects on subsidizing desert tortoise predators is substantial (reviewed under Subsidized Predators).

How was this threat addressed in the 1994 Recovery Plan?

Though anthropogenic water sources were identified as a threat in the 1994 Recovery Plan, the plan did not address the threat of anthropogenic water sources in its general recommendations for management of the DWMAs or in Appendix F.

How has the BLM implemented the Recovery Plan's measures?

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan recommends monitoring and limiting water development within several of the ACECs in the plan area, but currently there is not plan in place that assesses water development on wildlife resources, including desert tortoise.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendation that may be applied to the management of anthropogenic water sources:

Control use of landfills and sewage ponds by desert tortoise predators

The BLM should prohibit the use of open water sources for any purpose on BLM lands within the Conservation Area. Additionally, the BLM should be a participant in the planning and approval process of any water development within ten miles of the Conservation Area.

Landfills

How is this threat distributed within the Conservation Area and how has it limited tortoise populations?

There are several landfills inside the Conservation Area, however at least one has been closed and others are slated for closure. The development of new landfills has not occurred since the desert tortoise was listed in 1990. Therefore, over the period of study (1990-2008) the development of landfills *per se* has not affected desert tortoise populations within the Conservation Area, but their effects on subsidizing desert

tortoise predators is likely substantial (reviewed under Subsidized Predators). Our analysis indicates that landfills within and adjacent to the Conservation Area may subsidize ravens and coyotes that forage over a wide area there.

How was this threat addressed in the 1994 Recovery Plan?

The threat of landfills was addressed by the following general measure that was recommended for all DWMAs:

Prohibit landfills

Additionally, the USFWS recommended the immediate modification and control of landfills within the Superior-Cronese DWMA to prevent subsidizing predators of desert tortoises.

How has the BLM implemented the Recovery Plan's measures?

Under the CSDTMP, any surface-disturbing activity in Category I habitats can only be considered when the action cannot be implemented elsewhere, and surface disturbance in Category II and III habitats will be minimized through the implementation of mitigation measures. The CDCA Plan does not address landfill development. Most of the Conservation Area is technically open for landfill development (outside of existing ACECs), though once the West Mojave Plan is approved the entire Conservation Area will be designated as an ACEC, and landfill development would not likely occur.

What are additional or revised recommendations that should be considered?

The 1994 Recovery Plan includes the following general recommendation that pertains to managing landfills:

Control use of landfills and sewage ponds by desert tortoise predators

This recommendation could be implemented accordingly:

Though landfill development will not likely occur within the Conservation Area, the BLM may authorize landfills in the vicinity of desert tortoise Critical Habitat, including other Critical Habitat Units in the Western Mojave Recovery Unit. The BLM should ensure that any landfills that are permitted within ten miles of desert tortoise Critical Habitat are implemented with controls in place that prevent the subsidizing of common ravens, coyotes, and feral dogs.

4.3.2 Threats Management Prioritization

Threat Management Prioritization

We grouped the prioritized threats into tiers that represented different orders of magnitude between their adjusted scores (S_A). This allowed for further prioritization of threats into levels that would facilitate management decisions. Five groups of threats were distributed among 6 orders of magnitude in the adjusted scores; for ease we combined scores between 0.001 and 0.099999 within one tier. The resulting four tiers of threats and their level of management importance are presented in Table 23. The table may be used as a guide for prioritizing management decisions.

Table 23. Threats and Management Priorities for the Superior-Cronese Conservation Area

Tier	Threats	Management Priority
1	Roads Climate Change Invasive Plants Subsidized Predators Urbanization Drought Collection and Poaching by Humans Translocation of Tortoise Populations Agricultural Practices OHV Use Disease Mineral Extraction	**Critical Importance:** Pose a widespread, frequent, and significant threat to desert tortoise populations and should receive immediate, highly focused, and sustained management efforts
2	Degradation of Air Quality Railroads Toxin and Pollutant Deposition Military Activities Utilities Litter and Illegal Dumping	**High Importance:** Pose an important threat to desert tortoise populations due to their high frequency or wide distribution and should receive sustained management efforts to keep them from reaching critical importance
3	Livestock Grazing Fire	**Medium Importance:** Pose a threat to desert tortoise populations infrequently or at a local spatial scale and should receive periodic management efforts to keep them from reaching high importance
4	Anthropogenic Water Sources Landfills	**Low Importance:** Currently pose a low or negligible threat to desert tortoise populations, but should be monitored for future changes

Additional Recommendations

In addition to prioritizing the management of threats, we recommend the following:

- Areas outside of the habitat model likely support lower density desert tortoise populations. Modeled habitat should receive higher priority for management.

- A more prominent presence of law enforcement with BLM rangers should be applied to the Conservation Area.

- The Conservation Area contains an abundance of land in-holdings within its boundaries. The BLM should prioritize acquisition of in-holdings that contain desert tortoise habitat.

- The 1994 Recovery Plan recommends implementing appropriate administration, including a reserve manager, additional staff, and law enforcement personnel. These additional staff should reach out to the public through meeting with various user groups, forming local advisory committees, and developing educational and tourism opportunities. This recommendation is sound and should be pursued at the California Desert District Office, with assistance from the Barstow Field Office.

- Desert tortoise populations throughout the Superior-Cronese Conservation Area should be monitored with periodic surveys of the plots similar to those performed in support of this study in the Gold Butte-Pakoon Conservation Area. Survey of the plots every five years would, over the long term, allow the BLM to assess whether implementation of land management measures or removal of threats is affecting local desert tortoise populations. This would satisfy Guideline 39 in the CSDTMP, which recommends that study plots be established to evaluate management effectiveness.

- There is no accounting of the implementation of management measures within the Conservation Area, including those performed for desert tortoise recovery, in the public record. The California Desert District Office should implement a policy of annual reporting of management measures performed in support of desert tortoise recovery to better track the progress of recovery efforts.

4.4 CONCLUSIONS

The USFWS recommendations in the 1994 Recovery Plan were generally quite appropriate, especially given the state of scientific knowledge at the time. Our analysis determined that some of the general recommendations provided for management of all DWMAs could be applied to numerous threats, including those that the plan did not address. We found instances where both the general measures and the Specific Management Actions could be modified or improved in manners that were specific for each Conservation Area. As well, we found that many of the threats could be managed with additional measures that were not included in the 1994 Recovery Plan or the BLM land management plans.

The recommendations provided herein are appropriate for managing threats, but their prioritization should be considered preliminary. We expect that ecological and threat data collected during Phase 2 of the project, as well as the HexSim modeling that will be performed in support of Phase 3 of the project, will provide data and analyses that will allow for more rigorous and realistic prioritizations of threats and their management.

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Appendix A: Study Plot Descriptions

Table A-1. Plot Descriptions for the Control Treatment Area

Plot	1	2	13
Plot Location (NW corner)	(125) 236440E / 4078910N	(125) 232350E / 4071090N	756980E / 4065640N
County	Mohave	Mohave	Clark
State	Arizona	Arizona	Nevada
Topography	Plot is located on the Virgin Slope, and is characterized by gently sloping southeast to northwest alluvial surface with washes running in same direction.	Plot is located on the Virgin Slope, and is characterized by gently sloping east to west alluvial surface bajada.	Plot is located on the mid to upper portion of the Virgin Slope bajada, and is characterized by alluvial surface deeply incised (up to 100 feet) by ephemeral washes. 300 foot elevation change from south to north end of plot.
Hydrology	Braided ephemeral washes	Poorly incised ephemeral washes in braided channels	Ephemeral washes
Soils	Heterogeneous soil with rocks and boulders throughout; poorly sorted alluvium, cemented with caliche	Poorly sorted heterogeneous alluvium with sub-rounded to angular gravel to large cobble size	Undifferentiated gravels and cobbles associated with alluvial washes. High incidence of metamorphic rocks – angular to semi-rounded gravels and cobbles.
Caves	Some caves present in washes but not dominant feature	Sparse opportunities for cave formation due to lack of caliche layers of well developed cemented alluvium	Few areas of consolidated limestone/gravel and caliche exist on plot; Western side of plot appears to have higher concentration of caves
Vegetation Community	Creosote succulent scrub	Creosote succulent scrub	Creosote succulent scrub

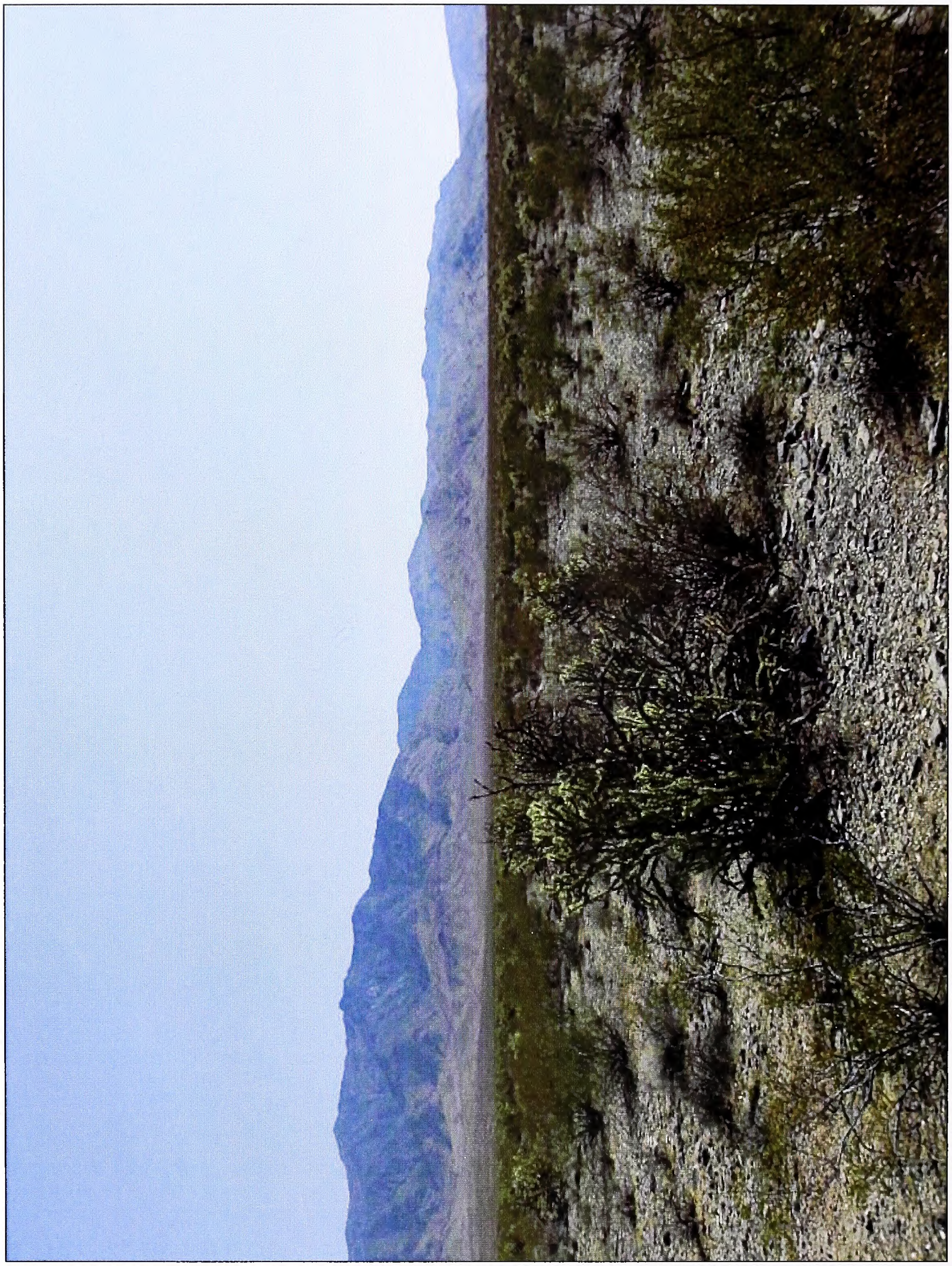

Figure A-1. View from the northwest corner of Plot 1, facing south.

Figure A-2. View from the northwest corner of Plot 2, facing southwest.

Figure A-3. View from the northwest corner of Plot 13, facing south.

Table A-2. Plot Descriptions for the Urban Treatment Area

Plot	3	14	15
Plot Location (NW corner)	(115) 754010E / 4069290 N	(115) 762770E / 4073070N	758490E / 4070660N
County	Clark	Mohave, Clark	Clark
State	Nevada	Arizona, Nevada	Nevada
Topography	Plot is located on the Virgin Slope, and is characterized by a southeast to northwest tilted alluvium surface with deep incision of washes running in same direction. Major wash bisecting the plot (200 meters wide).	Plot is located on the lower reaches of the Virgin Slope and is characterized by little change in elevation (< 50 feet).	Plot is located on the mid to lower reaches of the Virgin Slope bajada. Wash incisions are no more than 50 feet deep.
Hydrology	Ephemeral washes	Ephemeral washes	Large wash in eastern and northeastern portion of the plot. Smaller ephemeral washes over remainder of plot. Northeast corner of plot is characterized by several human-made dams and water catchment basins, probably associated with historic cattle grazing.
Soils	Unconsolidated alluvium in washes. Ridges characterized by mature, well-developed desert pavement.	Mixture of sands, and angular to semi-rounded gravels and cobble alluvium. Desert pavement extensive with areas of cryptobiotic soils.	Undifferentiated gravel and cobbles associated with bajada/alluvium. No dominant rock types. Sparse areas of cryptobiotic soils.
Caves	Good opportunities and quality of existing caliche caves due to well-developed/mature caliche layers	Very few areas of limestone/gravel consolidation providing for cave structure. Desert pavement common on the plot provides good burrowing opportunities.	Few areas of consolidated gravel/limestone and/or caliche caves. Those caves observed were characterized by recent tortoise activity.
Vegetation Community	Creosote succulent scrub	Creosote succulent scrub	Creosote-yucca scrub; plot dominated w/ creosote, Ambrosia, Yucca schidigera, and blackbush

Figure A-4. View from the northwest corner of Plot 3, facing east.

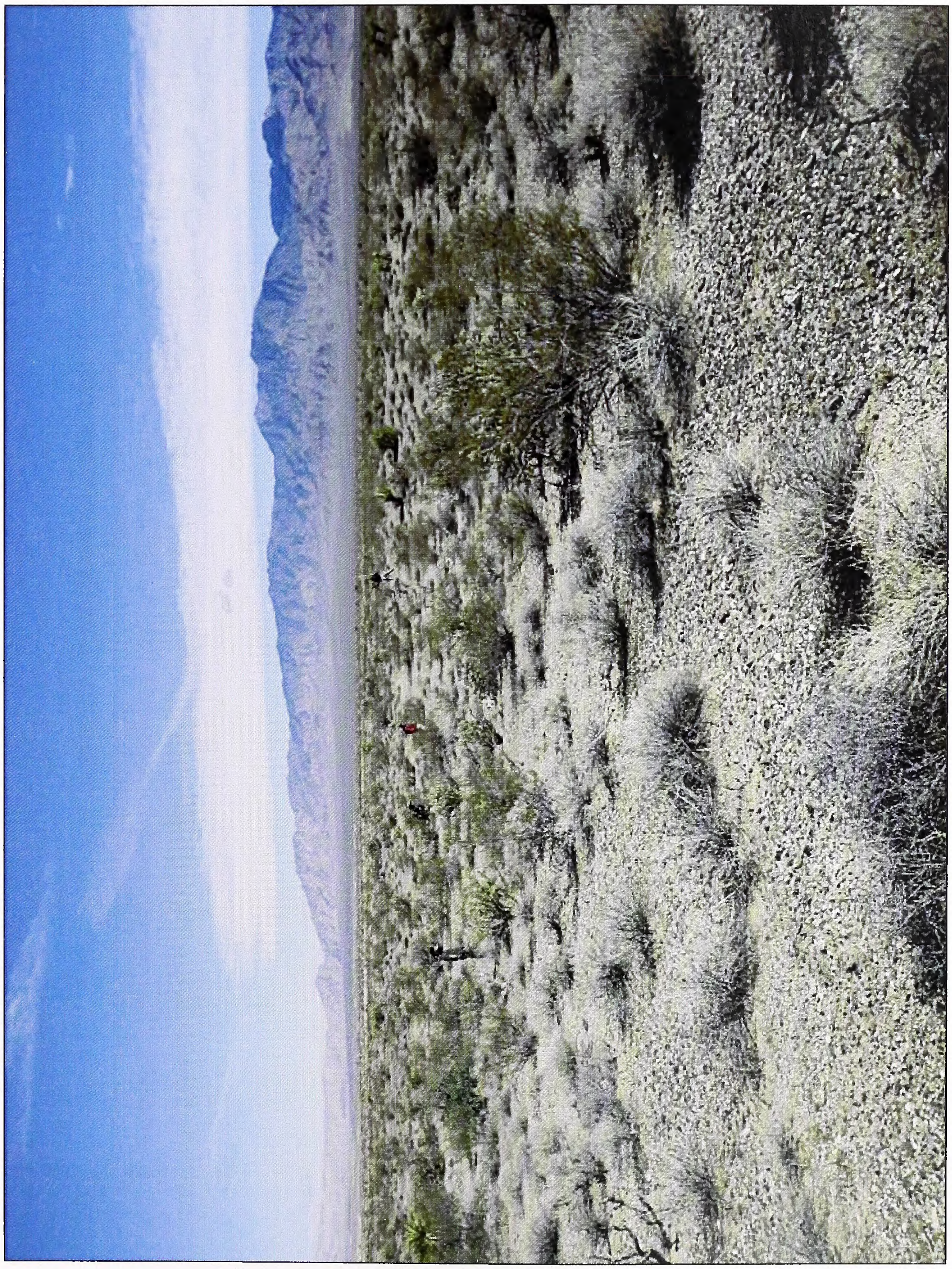

Figure A-5. View from the northwest corner of Plot 14, facing east.

Figure A-6. View from the northwest corner of Plot 15, facing south.
Table A-3. Plot Descriptions for the OHV Treatment Area

Plot	6	16	17
Plot Location (NW corner)	(115) 757470E / 4044300N	754480E / 4045860N	(115) 754280E / 4041240N
County	Clark	Clark	Clark
State	Nevada	Nevada	Nevada
Topography	Plot is located on the hillside of a ridge and adjacent valley floor within the Wechech Basin. The hillside is characterized by deeply incised (up to 200 feet) and steep-walled canyons.	Plot is located on the hillside of a ridge and adjacent valley floor within the Wechech Basin. The hillside is characterized by deeply incised (up to 200 feet) and steep-walled canyons.	Plot is located within a low-relief area characterized by rolling and tilted hills on a lower bajada. Maximum elevation change is less than 100 feet. Hills are characterized by some incisions.
Hydrology	Ephemeral washes in canyons and slope incisions. Cattle cistern on plot with water supply line running through plot.	Ephemeral washes	Ephemeral dendritic washes
Soils	Semi-rounded to angular alluvium.	Sandstone bedrock overlain with undifferentiated sandstone and limestone gravelly and sandy alluvial aggregate. Cryptobiotic soils development in areas not impacted by cattle grazing or OHV use.	Predominate gypsum base layer with undifferentiated cobble and gravel alluvium in the washes. Some tilted, plunging mudstone layers. Cryptobiotic soil development in all areas not directly impacted by cattle grazing, OHV use, or other anthropogenic disturbances.
Caves	Few lenses of caliche that would allow for cave development. All tortoises found on plot or near plot were found in or near soil burrows	Few areas of limestone/gravel consolidation, but some caves present on plot	Some small naturally existing caves between layers of gypsum, but no caliche or limestone gravel consolidation. Wash bank conglomerates are minimal. Most tortoise structures on plot are soil burrows.
Vegetation Community	Creosote-blackbush scrub	Creosote-yucca scrub	Ambrosia-Ephedra desert scrub

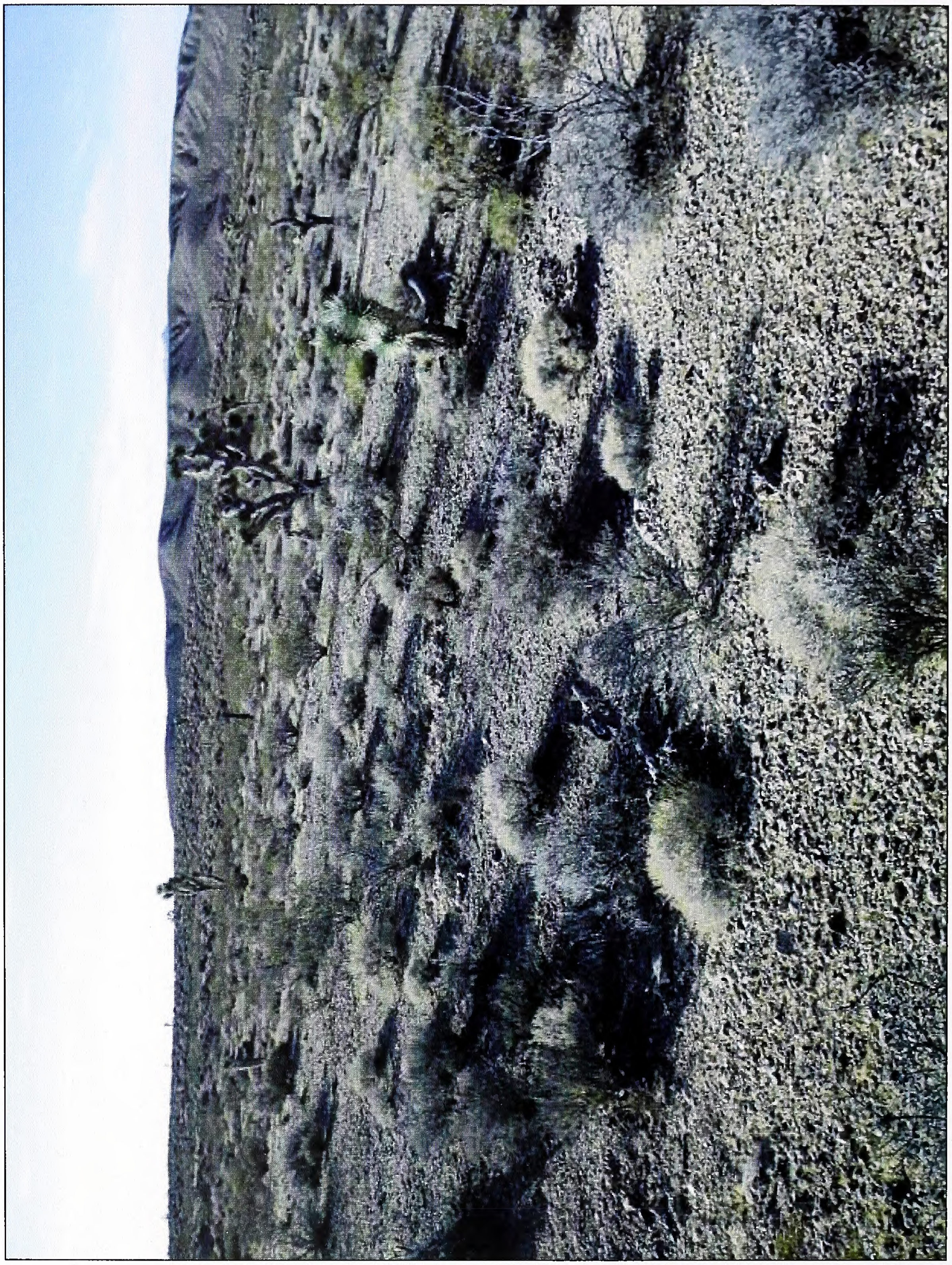

Figure A-7. View from the northwest corner of Plot 6, facing south.

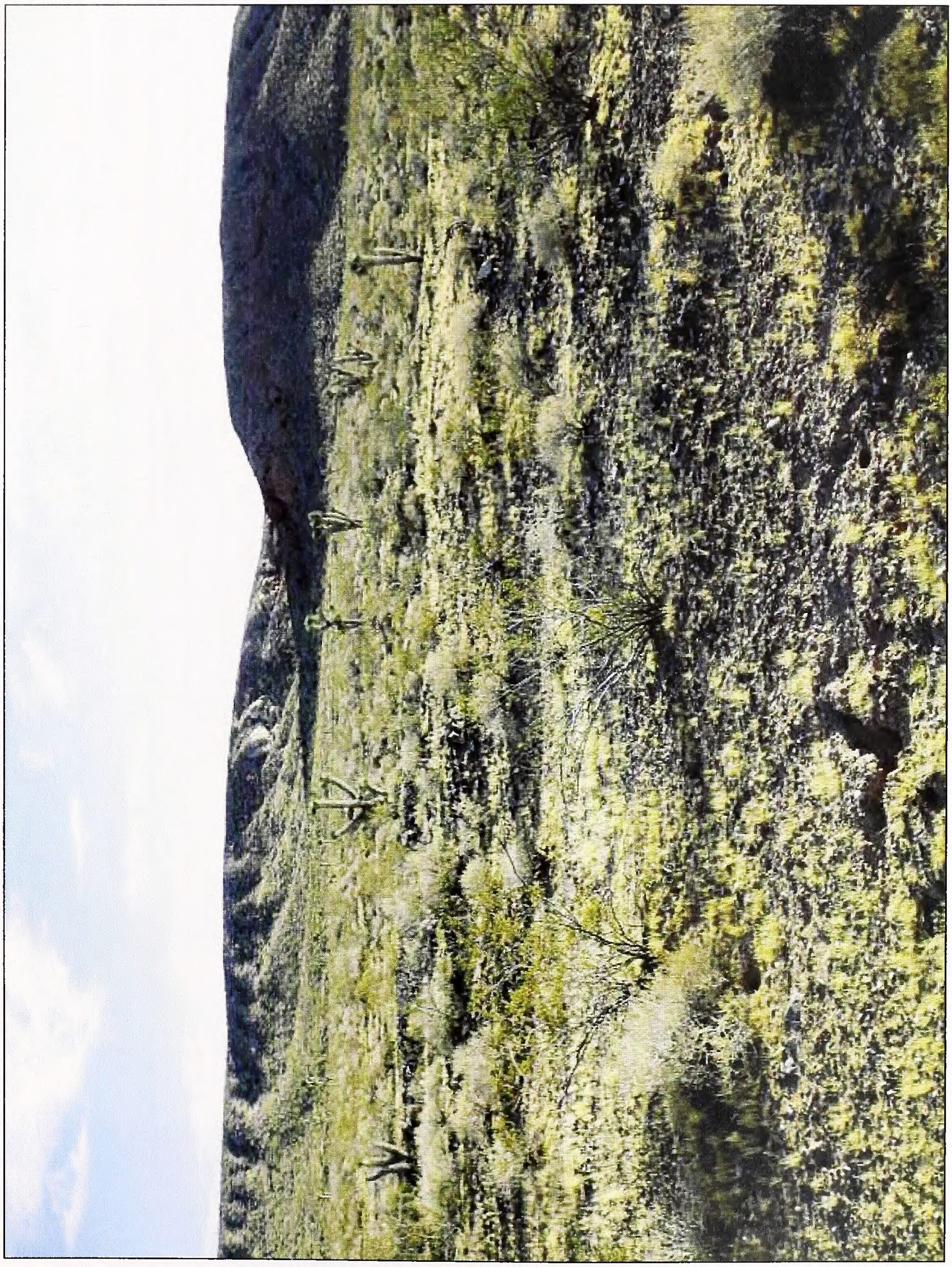

Figure A-8. View from the northwest corner of Plot 16, facing south.

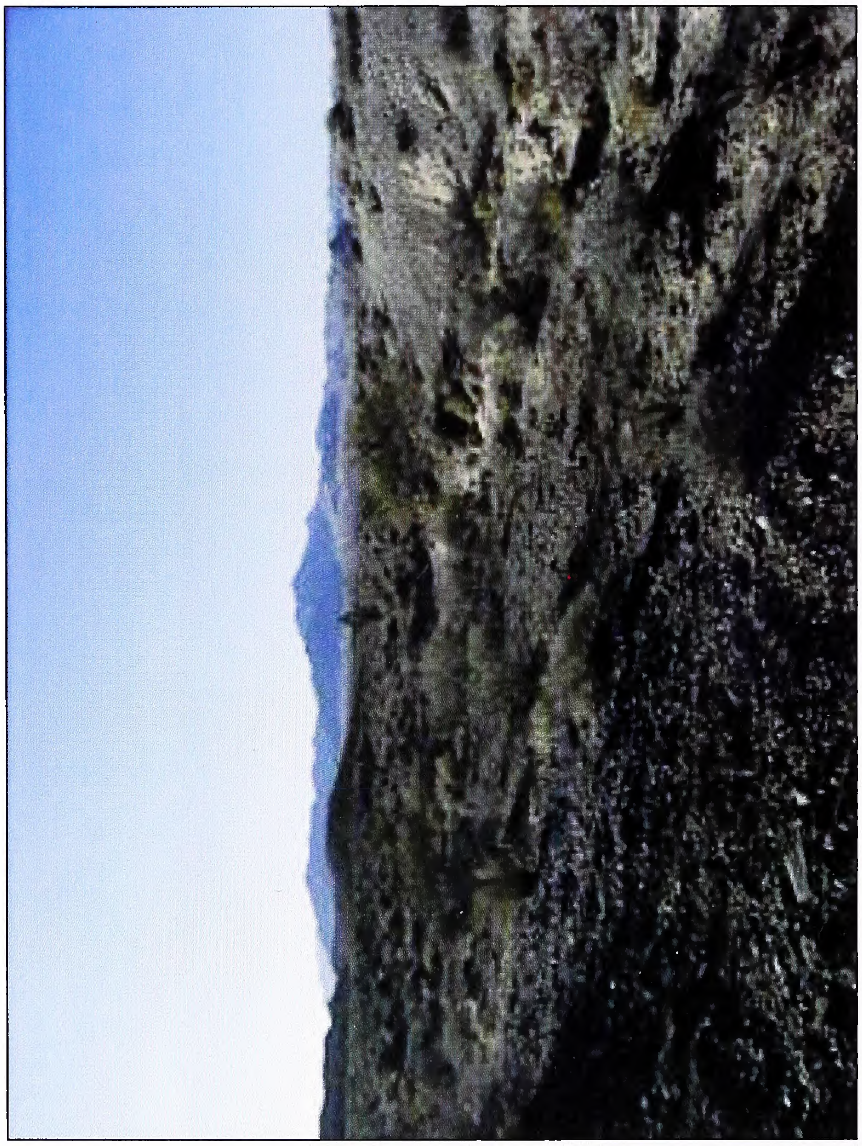

Figure A-9. View from the northwest corner of Plot 17, facing east.

Table A-4. Plot Descriptions for the Fire Treatment Area

Plot	7	8	9
Plot Location (NW corner)	(125) 231680E / 4046300N	(125) 246000E / 4048000N	(125) 234580E / 4049180N
County	Mohave	Mohave	Mohave
State	Arizona	Arizona	Arizona
Topography	Plot is located within the Pakoon Basin and is characterized by gently rolling, undulating hills.	Plot is located within the Pakoon Basin and is characterized by low-relief rolling hills on terrace adjacent to a large wash. Range of 50-100 foot elevation change over plot.	Plot is located within the Pakoon Basin and is characterized by a large, deeply incised (200-300 feet) canyon.
Hydrology	No washes/surface runoff only	Ephemeral washes	Ephemeral washes
Soils	Lithosols, silt-sized dark brown soil mixed with predominately angular to sub-angular gravel.	Alluvium over basalt bedrock. Basalt gravels and cobbles dominate landscape with mixed/undifferentiated alluvium gravels.	Angular to semi-rounded undifferentiated alluvium over basalt bedrock. Basalt cobbles and boulders found in washes.
Caves	No caves present on this plot	No caves present on this plot	Small area limestone consolidation/caliche within plot allowing for caves. Caves on plot showed sign of historic tortoise use. Some caves showed current use.
Vegetation Community	Post-fire revegetation succession	Post-fire revegetation succession with no dominant plant species	Recovering desert scrub; previous fires have denuded the vegetation; however, a wide variety of annuals exist on plot

Figure A-10. View from the northwest corner of Plot 7, facing south.

Figure A-11. View from the northwest corner of Plot 8, facing south.

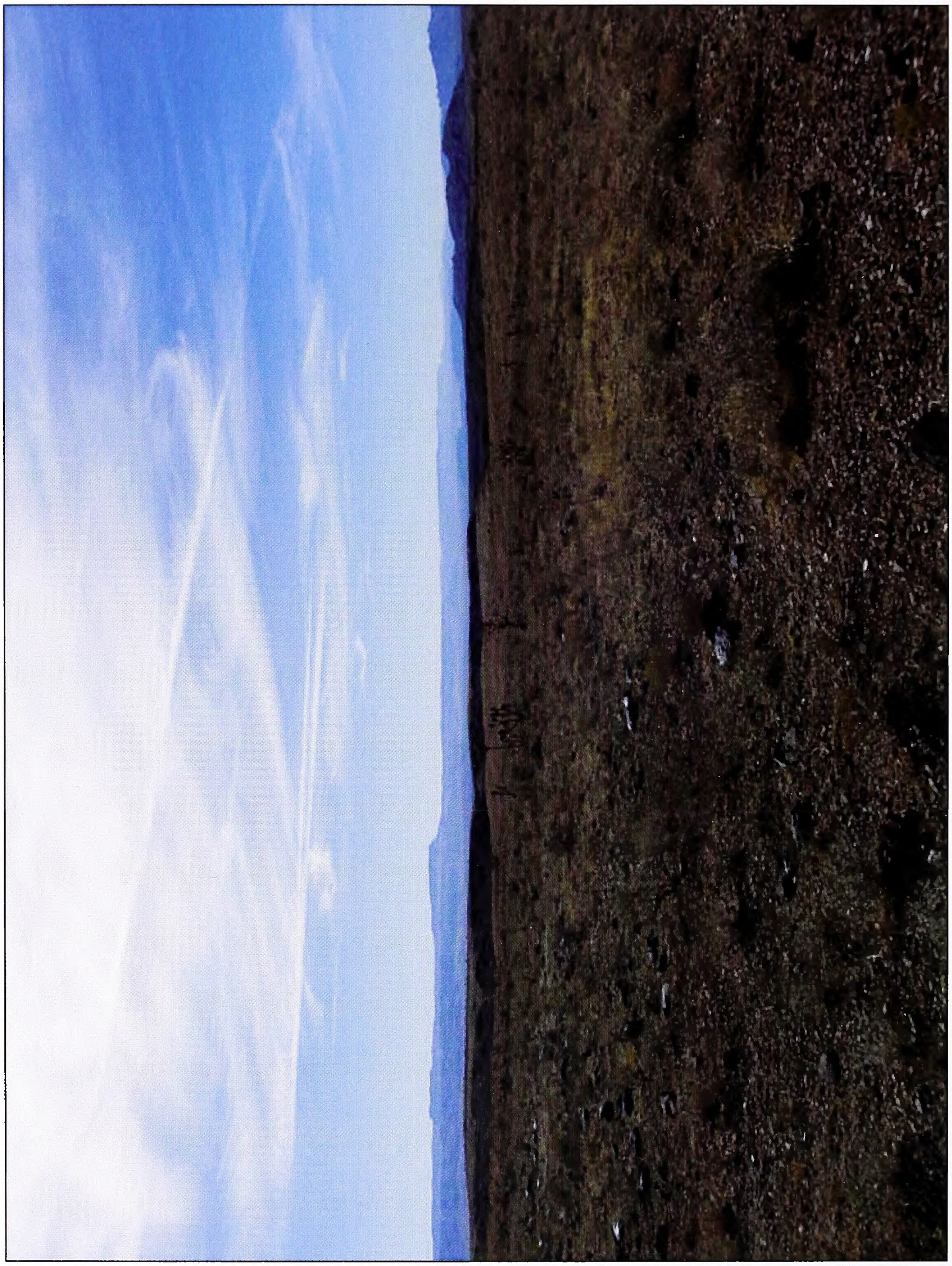

Figure A-12. View from the northwest corner of Plot 9, facing south.

Table A-5. Plot Descriptions for the Grazing Treatment Area

Plot	10	11	12
Plot Location (NW corner)	(125) 234530E / 4029350 N	(125) 232660E / 4022280N	241210E / 4012330N
County	Mohave	Mohave	Mohave
State	Arizona	Arizona	Arizona
Topography	Plot is located within the Pakoon Basin, and is characterized by level to sub-level (horizontal) basalt and carbonate topped mesas with deeply incised (105-200 ft) steep-sided canyons.	Plot is located within the Pakoon Basin, and is characterized by rolling alluvial deposits incised by numerous washes.	Plot is located within the Pakoon Basin, and is characterized by large wash adjacent to a steep plateau mesa situated in the eastern-central portion of the plot
Hydrology	Ephemeral washes, and evidence of substantial surface run-off following seasonal high intensity precipitation events.	Ephemeral washes	Due to historic and current cattle grazing and subsequent soil compaction, fissures and incisive downcutting is evident and extensive across the plot.
Soils	Dark tan to reddish tan soil (clay to sand sized) intermixed with predominately angular carbonate and sub-rounded to rounded basalt gravel. Locally abundant cryptobiotic soil crusts (predominately adjacent to active channels in washes).	Semi-rounded to angular mixture of nonspecific alluvium. Some patches of cryptobiotic soils exist on ridges between washes, but most cryptobiotic soil development has been eliminated by cattle grazing disturbances.	Predominantly undifferentiated angular and semi-rounded gravel and cobble alluvium. Some sandy areas present. All soils severely compacted from cattle grazing.
Caves	Shallow, crumbly caves formed from a weakly cemented conglomerate (poorly sorted weakly cemented alluvium) in washes and carbonate cap rock on mesa tops.	No caliche however, some areas of consolidated alluvium exist in washes that support small caves.	Little to no potential for cave development; no caves observed.
Vegetation Community	Creosote–bur-sage scrub	Creosote–bur-sage scrub	Creosote–bur-sage scrub

Figure A-13. View from the northwest corner of Plot 10, facing south.

Figure A-14. View from the northwest corner of Plot 11, facing south.

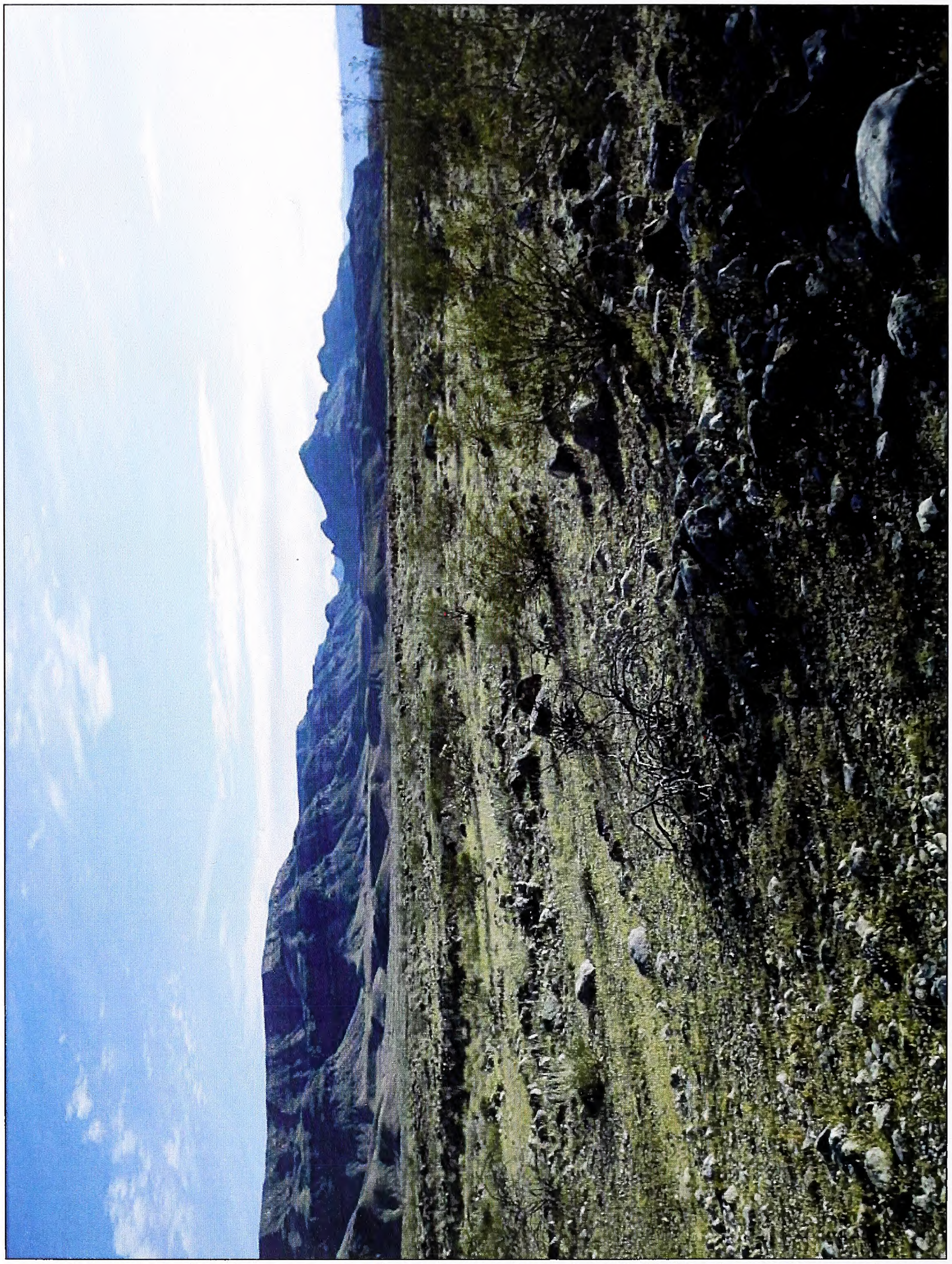

Figure A-15. View from the northwest corner of Plot 12, facing south.

Appendix B: Permits

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825-1846

IN REPLY REFER TO:
PSR/Recovery

APR 16 2009

Dear Permittee:

Enclosed is your U.S. Fish and Wildlife Service recovery permit issued under section 10(a)(1)(A) of the Endangered Species Act (ESA), 16 U.S.C. 1531 *et seq*., and its implementing regulations.

Please refer to the permit number in all correspondence and reports concerning permit activities. Engagement in any activity pursuant to this permit constitutes understanding and acceptance of the Special Terms and Conditions attached to your permit.

By accepting this permit and conducting activities authorized by it, you are agreeing to adhere to the attached terms and conditions. Failure to meet permit terms and conditions could result in ESA section 9 take violations, or suspension/revocation of this permit.

Please be aware that some species named in your recovery permit may also be listed under various State Endangered Species Acts or otherwise be of special concern to the States. As such, activities affecting those species may not be conducted without first obtaining the appropriate State permits. Federal permits do <u>not</u> supersede State authorizations.

If you have any questions regarding this matter, please contact Daniel Marquez at 760-431-9440. Thank you.

Sincerely,

for
Endangered Species Division Chief

Enclosures

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

3-201
(1/97)

U.S. FISH & WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

SWCA INC.
625 FAIR OAKS AVENUE, SUITE 190
SOUTH PASADENA, CA 91030
U.S.A.

2. AUTHORITY-STATUTES
16 USC 1533(d)

REGULATIONS *(Attached)*
50 CFR 17.32

50 CFR 13

3. NUMBER
TE195280-0

4. RENEWABLE
☐ YES
☒ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
04/17/2009

7. EXPIRES
04/16/2013

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
MICHAEL TUMA

9. TYPE OF PERMIT
THREATENED SPECIES

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
ON LANDS SPECIFIED WITHIN THE ATTACHED SPECIAL TERMS AND CONDITIONS

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

D. Further conditions of authorization are contained in the attached Special Terms and Conditions.

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 1/31

ISSUED BY	TITLE	DATE
Diane Elam	Act'g ENDANGERED SPECIES DIVISION CHIEF	04/17/2009

SPECIAL TERMS AND CONDITIONS
SWCA

1. Acceptance of this permit serves as evidence that the permittee understands and agrees to abide by the "General Conditions for Native Endangered and Threatened Wildlife Species Permits," 50 CFR Part 13, 50 CFR 17.22 (endangered wildlife) and/or 50 CFR 17.32 (threatened wildlife), as applicable (copies attached). In addition, the permittee must have all other applicable State, Federal, and Tribal permits prior to the commencement of activities authorized by this permit.

2. The permittee is authorized to take (capture, mark [glue a number, notch], weigh, measure, sex, attach radio transmitters, radiograph, collect blood samples, and release at the capture site) the desert tortoise (*Gopherus agassizii*) in conjunction with scientific research for the purpose of enhancing its survival, as specified in the permittee's January 16, 2009, permit request, in accordance with the conditions stated below.

3. Permitted activities are restricted to the following geographic areas/projects:

   a. Gold Butte-Pakoon life history/ecology study: Bureau of Land Management (BLM) lands within the Gold Butte-Pakoon (+ Part B) Desert Wildlife Management Area, Clark County, Nevada, and Mohave County, Arizona.

   b. Juvenile survivorship study: Department of Defense and BLM lands south of the Ft. Irwin National Training Center, San Bernardino County, California.

4. Authorized individuals:

   Only individuals on the attached List of Authorized Individuals (List) are authorized to conduct activities pursuant to this permit. The List, printed on U.S. Fish and Wildlife Service (Service) letterhead, may identify special conditions or circumstances under which individuals are authorized to conduct permitted activities and must be retained with these Special Terms and Conditions. Each named individual shall be responsible for compliance with the terms and conditions of this permit.

   To request changes to the List, the permittee shall submit written requests to the Service's Desert Tortoise Recovery Office (DTRO), 1340 Financial Blvd., Suite 234, Reno, Nevada 89502 (telephone: 775-861-6300; fax: 775-861-6301). Two copies of the request shall be submitted at least 30 days prior to the requested effective date. The request shall be signed and dated by the permittee and include:

   a. The name of each individual to be appended to the List;

   b. The resume/qualifications statement of each person to be appended to the List, detailing their experience with each species and type of activity, for which authorization is requested;

c. The names and phone numbers of a minimum of two references; and

d. The names of the individuals to be deleted from the List.

Note: This procedure is for personnel changes only. For requests to renew/amend this permit, a complete application must be submitted to the Endangered Species Division Chief at the Service's Regional Office for the California and Nevada Region (Region 8), 2800 Cottage Way, Room W-2606, Sacramento California 95825-1846.

5. Taking of the wild desert tortoise (tortoise) for the Gold Butte-Pakoon life history/ecology study at geographic location 4.a:

   a. The permittee is authorized to mark, capture, weigh, measure, sex, attach radio transmitters, collect blood samples, and release at the capture site 60 adult male, adult female, and juvenile (<180 mm carapace length) tortoises (up to 20 each size/sex class) within the geographic boundaries, terms and conditions, and the time limitation specified herein.

   b. The permittee is authorized to collect blood from the 60 individual desert tortoises specified above for a maximum of one time per season (Spring, April-May; Fall, September-October) to assess disease status during 2009 and 2010.

6. Taking of the tortoise for the juvenile survivorship study at geographic area 4.b:

   a. The permittee is authorized to mark, capture, weigh, measure, sex, attach radio transmitters, radiograph, collect blood samples, and release at the capture site 18 tortoises within the geographic boundaries, terms and conditions, and the time limitation specified herein.

   b. The permittee is authorized to collect blood from the 18 individual wild desert tortoises specified above a maximum of one time per year (between April and November) to assess disease status during 2009 and 2010.

   c. Tortoises at least 160 mm carapace length and displaying female morphological characters may be radiographed up to twice per season to determine the presence shelled eggs.

7. General terms and conditions for all tortoise activities:

   a. All personnel handling tortoises must be trained and implement the most recent Service-approved guidance developed for handling desert tortoises, *Guidelines for Handling Desert Tortoises during Construction Projects* (Desert Tortoise Council 1994, revised 1999), with the exception of guidance involving temperature and prevention of disease transmission. To prevent the spread of infectious diseases,

the permittee will implement the disease-prevention guidance in *Guidelines for the Field Evaluation of Desert Tortoise Health and Disease* (pages 433-434, *in* Berry and Christopher. 2001. J. Wildl. Diseases 37:427-450), and personnel will use a 10 percent solution of bleach for disinfection instead of alcohol. Any deviation from these protocols or the permittee's research proposal must first be approved in writing by the DTRO.

b. The permittee shall make every effort, when weighing, measuring, sexing, or attaching radio transmitters, to release each desert tortoise within one-half hour of its capture. Captured animals shall be released at the same location where they were initially observed. Animals shall remain in an upright position at all times.

c. No desert tortoise shall be captured, moved, transported, released, or purposefully caused to leave its burrow for whatever reason when the ambient air temperature is above 95 degrees Fahrenheit (35 degrees Celsius). No desert tortoise shall be captured if the ambient air temperature is anticipated to exceed 95 degrees Fahrenheit (35 degrees Celsius) before handling or processing can be completed. If the ambient air temperature exceeds 95 degrees Fahrenheit (35 degrees Celsius) during handling or processing, desert tortoises shall be kept shaded in an environment that does not exceed 95 degrees Fahrenheit (35 degrees Celsius), and the animals shall not be released until ambient air temperature declines to below 95 degrees Fahrenheit (35 degrees Celsius).

d. During all handling procedures, desert tortoises shall be treated in a manner to ensure that they do not overheat, exhibit signs of overheating (e.g., gaping, foaming at the mouth, etc.), or are placed in a situation where they cannot maintain surface and core temperatures necessary to their well-being. Desert tortoises shall be kept shaded at all times until it is safe to release them. For the purposes of this permit, ambient air temperature shall be measured in the shade, protected from wind, at a height of 2 inches (5 centimeters) above the ground surface.

e. Tortoises may be removed by hand from cover sites, by using a mirror to attract their attention, and by tapping (Medica, P.A. 1986. Tapping: a technique for capturing tortoises. Herp. Review 17:15-16). Care must be taken to avoid damage to the cover site, the cover site mound, entrance to the cover site, and to avoid excessive stress to the tortoise. Juvenile tortoises are especially sensitive to disturbance and are best caught when outside their cover sites or by tapping with a small stick or grass stem.

f. Desert tortoises shall not be transported by vehicle from the capture site unless instructed or authorized to do so by the DTRO. Desert tortoises shall never be placed in automobile trunks, on floorboards in an unconfined manner, in the bed of a truck over the exhaust system, or left unattended in vehicles.

g. Numbered tags and stakes that are used to mark desert tortoise burrows or other cover sites, or vegetation sampling locations, shall not consist of highly reflective material, and the tags shall be placed in an inconspicuous location. If marked desert tortoise burrows or other cover sites have not been used for a period of 3 or more years, the tags and stakes shall be removed and disposed.

h. The permittee shall limit vehicle use to existing routes that are designated as being open to vehicle use. Within desert tortoise habitat and during times when desert tortoises are likely to be active, the permittee and individuals on the List shall not operate motor vehicles in excess of 25 miles per hour on dirt roads, and they shall watch for and avoid all desert tortoises on the road.

i. Individual desert tortoises may be marked by one or both of the following methods:

   i. Tortoise identification numbers printed on paper or sticky labels or floy tags may be epoxied onto the shell.

   ii. Notches may be filed in marginal scutes. All notches will be filed with a sharp, triangular file. Files will be replaced as they get dull or begin to rust (due to bleach used for disinfection). Notches will be filed deeply, but not so deeply as to scar the bone. As much as possible, notches will be placed on the anterior or posterior portions of the scute to minimize impacts to the bone sutures.

j. Radio transmitters shall be attached to desert tortoises similar to the manner described in Boarman *et al.* (1998. Review of radio transmitter attachment techniques for turtle research and recommendations for improvement. Herp. Review 29:26-33). Radio transmitters and antennae must be mounted so as not to impede growth or the daily activities of the desert tortoise such as burrow construction, righting of overturned desert tortoises, and mating. The permittee has the responsibility to ensure that the well-being of the desert tortoise is not compromised by either the process of attaching radio transmitters or the location and operation of these devices.

   i. Placement and installation of radio antennae on desert tortoises shall be done in a manner that eliminates voids between the carapace and the antennae (i.e., the antennae attachment shall be flush with the carapace). Antennae may be left trailing unattached behind the tortoise.

   ii. The total mass of the instrumentation that is attached to each desert tortoise including antenna, epoxy, etc., shall not exceed 5 percent of the animal's body mass.

iii. Radio transmitters that contain weak batteries shall be removed or replaced before the batteries are likely to fail.

iv. Radio transmitters may temporarily (up to 48 hours) be attached to desert tortoises with duct tape, in situations in which full processing cannot be completed to comply with temperature guidelines in 8(c) above, or when light levels do not allow for processing.

v. Any shell damage from attachment or removal of radio transmitters shall be reported in writing within 3 working days to the DTRO.

vi. Adult transmittered desert tortoises shall be monitored at least monthly (year-round) to ensure that animals are not lost due to long-range movements beyond the area capable of being detected by telemetry equipment. Monitoring monthly is important even during the inactive period (when an animal is brumating). This will facilitate recapture in the spring when the desert tortoise first exits its burrow. If a desert tortoise has a malfunctioning transmitter it can be replaced before the animal becomes active. Juvenile tortoises with shorter life-span transmitters than those used on adults shall be monitored at least once a week during the active season.

vii. The permittee shall ensure that transmitters and other equipment are removed from all desert tortoises that can be located prior to the expiration date of this permit. In addition, the permittee shall exercise the best possible effort to locate and remove non-functioning transmitters and other equipment from all desert tortoises. This effort shall include thorough searches of each desert tortoise home range and previously occupied shelter sites. All efforts to locate such desert tortoises shall be documented within the annual and final reports described below, by an estimate of the number of hours spent or areas covered while searching for desert tortoises with non-functioning transmitters and other equipment. Deviation from these conditions requires prior written approval from the DTRO.

viii. The permittee may arrange, with the approval of the DTRO, to administratively transfer radio-telemetered desert tortoises to another individual permitted by the Service to telemeter desert tortoises. The permittee shall provide evidence to the Service that another permit holder has agreed to accept responsibility for transmitter maintenance and removal. The responsibility for transmitter removal applies to all permittees authorized to attach devices to desert tortoises and to all permittees that accept this responsibility from other permittees.

k. The permittee is authorized to collect blood from the subcarapacial sinus or brachial or femoral vein to assess disease status as follows:

i. Blood samples may be collected between the months of April and October. Tortoises with "suspect" ELISA test results may be re-sampled within the same month.

ii. For tortoises greater than or equal to 180 millimeters carapace length, the maximum amount of blood that will be collected from the brachial or femoral vein or subcarapacial sinus will be 2.0 cubic centimeters (total volume of all fluids) per sample.

iii. For tortoises less than 180 millimeters carapace length, the maximum amount of blood (total volume of all fluids) per sample that will be collected from the brachial vein or subcarapacial sinus will be calculated according to the October 2007 protocol for bleeding juvenile tortoises developed for this project or other updated protocol approved by the DTRO (Attachment 1).

iv. If the amount of blood that is drawn from an individual desert tortoise is more than what is required to address the three factors identified in the permittee's study proposal, this blood shall be archived and only used for the specific purposes that have been approved in writing by the DTRO. The facilities that archive unused blood shall only make such samples available to entities as approved or directed by the DTRO.

v. Tissues, blood, or other samples to be shipped to laboratories for analysis shall be accompanied by a copy of this permit to validate that the specimens were taken pursuant to a permit.

8. The number of tortoises allowed to be incidentally injured or killed during activities conducted pursuant to this permit is zero in any calendar year, including any mortality or injury suspected as a result of any part of the study methodology (i.e., coyote/raven depredation because radio transmitters increase desert tortoise visibility, etc.). In the event that an individual is injured or killed during the performance of permitted activities, the permittee must:

a. Immediately cease the activity resulting in injury or death until reauthorized by the DTRO, which may, after analysis of the circumstances of mortality or injury, revoke or amend this permit.

b. Immediately notify the DTRO and the Region 8 Recovery Permit Coordinator (telephone: 760-431-9440; fax: 760-930-0846). The permittee must follow up verbal notification in writing within 3 working days. For Arizona, this written report shall also be sent to the Arizona Game and Fish Department (Attention: Melissa Swain), 5000 W. Carefree Highway, Phoenix, AZ 85086 (telephone: 623-236-7625). For California, this written report shall also be sent to the California Department of Fish and Game (CDFG), Attention: Permit Biologist, Wildlife

Branch, 1812 Ninth Street, Sacramento, California 95811 (telephone: 916-445-3764). For Nevada, this written report shall also be sent to the Nevada Department of Wildlife, 4747 Vegas Drive, Las Vegas, Nevada 89108 (telephone: 702-486-5127 x3718).

With the written notification, the permittee shall include a report of the circumstances that led to the injury or mortality. A description of the changes in activity protocols that will be implemented to reduce the likelihood of such injury or mortality from happening again should be included, if appropriate. The incident shall also be discussed in the annual report that is subsequently submitted.

c. Preserve any dead specimens in accordance with standard museum practices. Before expiration of the permit, all preserved specimens will be properly labeled and deposited with the designated depository. The permittee shall supply the depository with a copy of this permit to validate that the specimens were taken pursuant to a permit.

9. Designated depositories:

The Wildlife and Fisheries Museum, University of California, Davis, California; the Museum of Vertebrate Zoology, University of California, Berkeley, California; or the DTRO may approve other depositories.

10. Annual reports:

a. An annual report of activities shall be submitted in *electronic* format to the DTRO by January 31, following each year this permit is in effect. The annual report shall contain the following sections and information for each separate project/site implemented during the calendar year: (i) an abstract; (ii) an introduction section addressing reasons and objectives for taking the species; (iii) a methodology section addressing data collection and analysis procedures; (iv) a results section that summarizes the data collected, including numbers of tortoises handled and/or salvaged, carcasses collected, biological samples collected, as well as preliminary analyses; and (v) a conclusion section that specifically provides recommendations for recovery of the species.

b. In each annual report, the permittee shall provide a table that includes an estimate (to the nearest 0.2 cubic centimeters) of the volume of unused blood and serum that remains from the sample(s) collected from individual desert tortoises, after the sample(s) was/were used to provide material to determine disease status, stress levels, and genetic characteristics. For each sample of unused blood, the table will also include: (i) a unique identifier number for the desert tortoise that blood was drawn from; (ii) the date the blood was collected; and (iii) the name of the facility where the unused blood or serum is stored. Each annual report will also quantify

the number of skeletal remains that were collected during the prior year, and identify the facility where those remains are archived.

c. Each annual report shall also include, but not be limited to: (i) maps or other appropriate figures depicting the location of the study site; (ii) the numbers and location of tortoises that may have died each year; (iii) if animals voided their bladder when handled; (iv) other pertinent observations made during sampling efforts regarding the status or ecology of the species; and (v) the status of all transmittered tortoises.

d. An Excel spreadsheet and metadata document for radio transmitter information is located on the Ventura Fish and Wildlife Office website at: http://www.fws.gov/ventura/speciesinfo/protocols_guidelines/. The geographic coordinates that shall be provided in the spreadsheet shall be in a Universal Transverse Mercator projection, NAD-83 datum, and the units shall be in meters. These records shall be submitted with the annual report to the DTRO. Please return the completed Excel form to Roy Averill-Murray in the DTRO via e-mail at roy_averill-murray@fws.gov.

e. If no activities occurred over the course of the year, indication of such shall be submitted as an annual report.

11. Failure to comply with reporting requirements may result in the non-renewal or suspension/revocation of this permit.

4/17/09
Date

Diane Elam
Acting Endangered Species Division Chief

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825-1846

LIST OF AUTHORIZED INDIVIDUALS
TE-195280-0

1. Individuals authorized to conduct all activities pursuant to this permit, with the exception of blood sampling, are:

   Michael Tuma, Scott Hillard, Paula Kahn, Ken Nagy, Matthew McMillan, and Rebecca Kipp.

2. Individuals authorized to collect blood samples from tortoises via subcarapacial venipunture:

   Michael Tuma, Scott Hillard, Paula Kahn, and Ken Nagy.

3. Individuals authorized to collect blood samples from tortoises via brachial or femoral venipunture:

   Paula Kahn. Matthew McMillan may be authorized to conduct this activity under the direct supervision of Paula Kahn or independently upon notification by Dr. Kahn of Mr. McMillan's qualifications.

4. Indiviuduals authorized to handle, weigh, measure, radio-track, and observe desert tortoises are:

   Daniel Essary and Brent Sparks.

Supervised individuals may conduct activities pursuant to this permit only under the direct, on-site supervision of the appropriate above-named authorized individual.

4/17/09
Date

Diane Elam
Acting Endangered Species Division Chief

This List is valid only if it is dated on or after the permit issuance date.

Protocol for Bleeding Juvenile Tortoises

K.H. Berry (October 2007)

This protocol was developed from correspondence by electronic mail with Lori Wendland, DVM, Ph.D., an expert with gopher tortoises and a scientist in the Department of Infectious Diseases and Pathology, College of Veterinary Medicine, University of Florida, Gainesville.

With the gopher tortoise, Dr. Wendland generally uses the subcarapacial technique only when necessary. She and her team have been successful with drawing blood from the brachial vein, even in very small tortoises. However, our case with the Ft. Irwin juveniles is different, because they are highly likely to have experienced water and nutritional deficits during the last year. They are probably dehydrated, and the subcarapacial venipuncture site would likely be the more successful site.

The following procedure is sequential:

1. The pen(s) will be watered by DPW staff, hopefully causing the tortoises to emerge and drink at the base of poles and elsewhere. Emergence with artificial watering should reduce human trampling of the pens. During or shortly after watering, a few individuals will enter the pens with containers, Sharpies, and pin flags. They will collect the tortoises, put them in containers (labeled on-site with the tortoise identification number), and remove them from the pen to the processing area. A pin flag with the tortoise identification number will be written onto the flag itself and the quadrat in the pen (or similar identification) will be noted on the container and journal sheet. The pin flag will be placed at the collection point of the tortoise.

2. Each tortoise should be processed for length and weight, photographed, and data collected on the health evaluation data sheets. Look closely for chews by rodents in the axillary and inguinal areas.

3. The tortoise will be hydrated in the containers with its identification number.

4 Based on the length and weight measurements, the maximum amount of blood that can be safely drawn will be noted using the information below. I have summarized calculations below, based both on what Dr. Wendland has provided and using measurements of length and weight in Berry et al. 2002 (Deaths of desert tortoises following periods of drought and research manipulation). The amount varies by size class and should be easy to follow.

The calculations in Table 1 (next page) are based on the following equation:

Maximum blood draw (ml) = Body Weight of tortoise to be bled (kg) x 1000 g/kg x estimated 6% blood volume x 10%

5. After blood draw and, where appropriate, the nasal lavage, the tortoise will be rehydrated again.

6. The tortoise will be returned to the pen to the point of capture and the pin flag removed for use with another tortoise.

7. The tortoise will be checked within a few hours to determine if it has moved (returned to cover site). If it does not return to its cover site or a cover site, that should be noted. Someone should be keeping track of these behaviors, as they indicate poor condition.

Table 1. Amounts of blood that may be drawn from small tortoises by carapace length at the midline (mm, MCL.

Size of tortoise (mm, MCL)	Amount of blood to be drawn (ml)
< 80*	0.15–0.25, with the upper level more desirable. For the 45 g tortoise, the lower number must be used.
80–100	0.5–0.6
>100–140	0.6–1.0
>140–179	>1.0–2.0

*Call me if the weight of the tortoise, after hydration, falls below the 95% confidence interval on Figure 3a (pg. 442) of Berry et al, "Deaths of desert tortoises following periods of drought and research manipulation."

Specifications on special equipment to be used

1. You should use the 25 gauge needles (most are 5/8"), and the microtainers **without** the clay separators.
2. The small calipers and scales should be used.

Other recommendations:

1. Read the Berry et al. paper and the protocol before starting work. Pay close attention to clinical signs for dehydration and starvation, e.g., muscle wasting, lethargy, sunken eyes, closed eyes, low weights, spending the night outside a cover site, failure to seek cover at night. Be careful to record all details. Take notes on where the tortoise was in the pen at the time of capture. Does it have a burrow? Are several bunched together trying to use a single cover site?

2. **CRITICAL.** Use the small calipers and the small weights; **get accurate weights prior to rehydration, then after as well. Make notes on these weights on page 1 of the data sheet.**

3. For the very small tortoises, do not try the nasal lavage.

4. There are about 75 containers (new) with lids. In addition, there is a package of new paper bowls, which will be useful for the very small tortoises (40-55 mm MCL). You can write the identification numbers of the tortoise on these containers with the Sharpie, and the container should stay with the tortoise. You may wish to write the pen number, as well as the quadrat within the pen.

5. Practice the regular disinfection procedures. Remember to disinfect containers if you re-use them. Please return them back to the lab for other uses and for re-cycling, where necessary.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

California/Nevada Operations Office
2800 Cottage Way, Room W-2606
Sacramento, CA 95825-1846

Implemented September 1994

GENERAL CONDITIONS FOR NATIVE ENDANGERED AND THREATENED WILDLIFE SPECIES PERMITS

1. All sections of Title 50 Code of Federal Regulations Part 13 are conditions of the permit.

2. All applicable foreign, State, local, or other Federal laws, including trespass laws, and other laws requiring permits, must be observed.

3. The permittee must carry a copy of the permit while conducting authorized activities.

4. The permit number must be legibly printed on all documents and advertisements involving activities conducted under a permit.

5. Unless otherwise authorized on the face of the permit, the wildlife must be immediately released at or near the capture site after the permitted activity.

6. Living specimens must be handled and shipped so as to minimize risk of injury, damage to health or cruel treatment.

7. The container in which authorized wildlife is shipped must be plainly marked with names and addresses of shipper and consignee and an accurate description of the contents including common and scientific name and number of each within.

8. Any dead or injured specimens of the authorized wildlife found may be salvaged or cared for.

9. BIRD BANDING, marking, radio tagging, etc., must be conducted in accordance with a Federal Bird Marking and Salvage Permit.

10. At the discretion of the Service, a Service employee may inspect the facilities or accompany the permittee during any activity conducted pursuant to this permit. The permittee shall allow Service personnel complete and immediate access to any materials and information generated as a result of this permit. Any refusal, obstruction, or hindrance of Service participation in such work shall be grounds for suspension or revocation of this permit in accordance with 50 CFR 13.27 or 50 CFR 13.28, respectively.

THE FOLLOWING CONDITIONS APPLY UNTIL AUTHORIZED DISPOSAL OF THE WILDLIFE (LIVE OR DEAD), AND THEIR PROGENY, REGARDLESS OF THE EXPIRATION DATE OF THE PERMIT:

11. The authorized wildlife may NOT be sold, donated, or transferred without written authorization from the Service.

12. Any dead authorized wildlife shall be preserved according to standard museum practices and held for scientific purposes whenever practical.

13 Any live SEA TURTLES held must be maintained in accordance with the "Standards for Care and Maintenance of Sea Turtles Held in Captivity" specified by the Service.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Nevada Fish and Wildlife Office
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: (775) 861-6300 ~ Fax: (775) 861-6301

May 8, 2009
Permit No. TE-195280-0

Michael Tuma
SWCA Inc.
625 Fair Oaks Avenue, Suite 190
South Pasadena, California 91030

Dear Mr. Tuma:

Subject: Correction to TE-195280-0 for the Desert Tortoise (*Gopherus agassizii*)

Special Term and Condition 6a of the subject permit allows you to "mark, capture, weigh, measure, sex, attach transmitters, radiograph, collect blood samples, and release … 18 tortoises" in the permitted juvenile survivorship study. The limitation of this term and condition to 18 tortoises was an oversight, as your permit application requested that these procedures also apply to additional, opportunistically sampled wild tortoises. In consideration of your original request, we have provided for an additional 12 opportunistic tortoises to be included under the permit. This letter replaces Term and Condition 6a of your current permit with the following:

6. Taking of the tortoise for the juvenile survivorship study at geographic area 4.b:

   a. The permittee is authorized to mark, capture, weigh, measure, sex, attach radio transmitters, radiograph, collect blood samples, and release at the capture site 30 tortoises within the geographic boundaries, terms and conditions, and the time limitation specified herein.

If we can be of further assistance, please contact Roy Averill-Murray at (775) 861-6362.

Sincerely,

Roy C Averill-Murray

for Robert D. Williams
Field Supervisor

cc: Field Supervisor, Ventura Fish and Wildlife Office, Ventura, California
Chief, Division of Recovery, Section 10, and Listing, Ecological Services, Fish and Wildlife Service, Sacramento, California (Attn: Daniel Marquez)

United States Department of the Interior
Fish and Wildlife Service
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: 775-861-6300 ~ Fax: 775-861-6301

TAKE PRIDE IN AMERICA

September 2, 2009
Permit No. TE-195280-0

Michael W. Tuma
Natural Resources Program Manager
SWCA Environmental Consultants
625 Fair Oaks Avenue, Suite 190
South Pasadena, CA 91030

Dear Mr. Tuma:

Subject: Request to Change the List of Authorized Individuals for Recovery Permit TE-195280-0 for the Desert Tortoise (*Gopherus agassizii*)

Attached is a change to the List of Authorized Individuals (List) for Recovery Permit TE-195280-0 based on your email request of August 27, 2009.

Please remove the current List from your permit documents and replace it with the attached signed List. This List supersedes all previous lists. If we can be of further assistance, please contact Roy Averill-Murray at (775) 861-6362.

Sincerely,

Roy C A-M

for Robert D. Williams
State Supervisor

Enclosure

cc: Chief, Division of Recovery, Section 10, and Listing, Ecological Services, Fish and Wildlife Service, Sacramento, California (Attn: Daniel Marquez)
Field Supervisor, Ventura Fish and Wildlife Office, Ventura, California
Field Supervisor, Arizona Ecological Services Office, Phoenix, Arizona
California Department of Fish and Game, Wildlife Branch, Sacramento, CA (Esther Burkett)
Arizona Game and Fish Department, Phoenix, AZ (Melissa Swain)
Nevada Department of Wildlife, Reno, NV (Doug Hunt)

United States Department of the Interior
Fish and Wildlife Service
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: 775-861-6300 ~ Fax: 775-861-6301

TAKE PRIDE IN AMERICA

LIST OF AUTHORIZED INDIVIDUALS
TE-195280-0

1. Individuals authorized to conduct all activities pursuant to this permit, with the exception of blood sampling, are:

   Michael Tuma, Scott Hillard, John Hillman, Paula Kahn, Ken Nagy, Matthew McMillan, and Rebecca Kipp.

1. Individuals authorized to collect blood samples from tortoises via subcarapacial venipunture:

   Michael Tuma, Scott Hillard, John Hillman, Paula Kahn, and Ken Nagy.

3. Individuals authorized to collect blood samples from tortoises via brachial or femoral venipunture:

   Paula Kahn. Matthew McMillan may be authorized to conduct this activity under the direct supervision of Paula Kahn or independently upon notification by Dr. Kahn of Mr. McMillan's qualifications.

4. Indiviuduals authorized to handle, weigh, measure, mark, radio-track, and observe desert tortoises are:

   Daniel Essary, Brenda Hanley, Abraham Role, and Brent Sparks.

Supervised individuals may conduct activities pursuant to this permit only under the direct, on-site supervision of the appropriate above-named authorized individual.

9/2/09
Date

for State Supervisor

This List is valid only if it is dated on or after the permit issuance date.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825-1846

IN REPLY REFER TO:
PSR/Recovery
TE195280-1

APR 5 2010

Dear Permittee:

Enclosed is your U.S. Fish and Wildlife Service recovery permit issued under section 10(a)(1)(A) of the Endangered Species Act (ESA), 16 U.S.C. 1531 *et seq.*, and its implementing regulations.

Please refer to the permit number in all correspondence and reports concerning permit activities. Engagement in any activity pursuant to this permit constitutes understanding and acceptance of the Special Terms and Conditions attached to your permit.

By accepting this permit and conducting activities authorized by it, you are agreeing to adhere to the attached terms and conditions. Failure to meet permit terms and conditions could result in ESA section 9 take violations, or suspension/revocation of this permit.

Please be aware that some species named in your recovery permit may also be listed under various State Endangered Species Acts or otherwise be of special concern to the States. As such, activities affecting those species may not be conducted without first obtaining the appropriate State permits. Federal permits do <u>not</u> supersede State authorizations.

If you have any questions regarding this matter, please contact Daniel Marquez at 760-431-9440. Thank you.

Sincerely,

for
Endangered Species Division Chief

Enclosures

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

3-201
(1/97)

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

SWCA INC.
dba SWCA ENVIRONMENTAL CONSULTANTS
625 FAIR OAKS AVENUE, SUITE 190
SOUTH PASADENA, CA 91030
U.S.A.

2. AUTHORITY-STATUTES
16 USC 1533(d)

REGULATIONS
50 CFR 17.32

50 CFR 13

3. NUMBER
TE195280-1 AMENDMENT

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
03/19/2010

7. EXPIRES
04/16/2013

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
MICHAEL W TUMA
NATURAL RESOURCES PROGRAM MANAGER

9. TYPE OF PERMIT
NATIVE THREATENED SP. SUBRECOVERY - T WILDLIFE

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
ON LANDS SPECIFIED WITHIN THE ATTACHED SPECIAL TERMS AND CONDITIONS

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

D. Further conditions of authorization are contained in the attached Special Terms and Conditions.

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 01/31

ISSUED BY	TITLE	DATE
Michael M. Long	ENDANGERED SPECIES DIVISION CHIEF	03/19/2010

SPECIAL TERMS AND CONDITIONS
SWCA

1. This permit was previously issued on April 17, 2009. The terms and conditions set forth in that permit are hereby superseded by this permit.

2. Acceptance of this permit serves as evidence that the permittee understands and agrees to abide by the "General Conditions for Native Endangered and Threatened Wildlife Species Permits," 50 CFR Part 13, 50 CFR 17.22 (endangered wildlife) and/or 50 CFR 17.32 (threatened wildlife), as applicable (copies attached). In addition, the permittee must have all other applicable State, Federal, and Tribal permits prior to the commencement of activities authorized by this permit.

3. The permittee is authorized to take (capture, mark [glue a number, notch], weigh, measure, sex, attach radio transmitters, radiograph, collect blood and nasal lavage samples, and release at the capture site) the desert tortoise (*Gopherus agassizii*) in conjunction with scientific research for the purpose of enhancing its survival, as specified in the permittee's October 8, 2009, permit amendment request, in accordance with the conditions stated below.

4. Permitted activities are restricted to the following geographic areas/projects:

   a. Gold Butte-Pakoon life history/ecology study: Bureau of Land Management (BLM) lands within the Gold Butte-Pakoon (+ Part B) Desert Wildlife Management Area, Clark County, Nevada, and Mohave County, Arizona.

   b. Juvenile survivorship study: Department of Defense and BLM lands south of the Ft. Irwin National Training Center, San Bernardino County, California.

5. Authorized individuals:

   Only individuals on the attached List of Authorized Individuals (List) are authorized to conduct activities pursuant to this permit. The List, printed on U.S. Fish and Wildlife Service (Service) letterhead, may identify special conditions or circumstances under which individuals are authorized to conduct permitted activities and must be retained with these Special Terms and Conditions. Each named individual shall be responsible for compliance with the terms and conditions of this permit.

   To request changes to the List, the permittee shall submit written requests to the Service's Desert Tortoise Recovery Office (DTRO), 1340 Financial Blvd., Suite 234, Reno, Nevada 89502 (telephone: 775-861-6300; fax: 775-861-6301). The request shall be submitted at least 30 days prior to the requested effective date. The request shall be signed and dated by the permittee and include:

   a. The name of each individual to be appended to the List;

b. The resume/qualifications statement of each person to be appended to the List, detailing their experience with each species and type of activity, for which authorization is requested;

c. The names and phone numbers of a minimum of two references; and

d. The names of the individuals to be deleted from the List.

Note: This procedure is for personnel changes only. For requests to renew/amend this permit, a complete application must be submitted to the Endangered Species Division Chief at the Service's Regional Office for the Pacific Southwest Region (Region 8), 2800 Cottage Way, Room W-2606,

6. Taking of the wild desert tortoise (tortoise) for the Gold Butte-Pakoon life history/ecology study at geographic location 4.a:

    a. The permittee is authorized to mark, capture, weigh, measure, sex, attach radio transmitters, collect blood and nasal lavage samples, and release at the capture site 120 adult male, adult female, and juvenile (<180 mm carapace length) tortoises (up to 40 each size/sex class) within the geographic boundaries, terms and conditions, and the time limitation specified herein.

    b. The permittee is authorized to collect blood and nasal lavages from 60 individual desert tortoises of those specified above for a maximum of one time per season (Spring, April-May; Fall, September-October) to assess disease status during 2009 and 2010.

7. Taking of the tortoise for the juvenile survivorship study at geographic area 4.b:

    a. The permittee is authorized to mark, capture, weigh, measure, sex, attach radio transmitters, radiograph, collect blood samples, and release at the capture site 30 tortoises within the geographic boundaries, terms and conditions, and the time limitation specified herein.

    b. The permittee is authorized to collect blood from the 30 individual wild desert tortoises specified above a maximum of one time per year (between April and November) to assess disease status during 2009 and 2010.

    c. Tortoises at least 160 mm carapace length and displaying female morphological characters may be radiographed up to twice per season to determine the presence shelled eggs.

8. General terms and conditions for all tortoise activities:

a. All personnel handling tortoises must be trained and implement the most recent Service-approved guidance developed for handling desert tortoises, *Guidelines for Handling Desert Tortoises during Construction Projects* (Desert Tortoise Council 1994, revised 1999), with the exception of guidance involving temperature and prevention of disease transmission. To prevent the spread of infectious diseases, the permittee will implement the disease-prevention guidance in *Guidelines for the Field Evaluation of Desert Tortoise Health and Disease* (pages 433-434, *in* Berry and Christopher. 2001. J. Wildl. Diseases 37:427-450), and personnel will use a 10 percent solution of bleach for disinfection instead of alcohol. Any deviation from these protocols or the permittee's research proposal must first be approved in writing by the DTRO.

b. The permittee shall make every effort, when weighing, measuring, sexing, or attaching radio transmitters, to release each desert tortoise within one-half hour of its capture. Captured animals shall be released at the same location where they were initially observed. Animals shall remain in an upright position at all times.

c. No desert tortoise shall be captured, moved, transported, released, or purposefully caused to leave its burrow for whatever reason when the ambient air temperature is above 95 degrees Fahrenheit (35 degrees Celsius). No desert tortoise shall be captured if the ambient air temperature is anticipated to exceed 95 degrees Fahrenheit (35 degrees Celsius) before handling or processing can be completed. If the ambient air temperature exceeds 95 degrees Fahrenheit (35 degrees Celsius) during handling or processing, desert tortoises shall be kept shaded in an environment that does not exceed 95 degrees Fahrenheit (35 degrees Celsius), and the animals shall not be released until ambient air temperature declines to below 95 degrees Fahrenheit (35 degrees Celsius).

d. During all handling procedures, desert tortoises shall be treated in a manner to ensure that they do not overheat, exhibit signs of overheating (e.g., gaping, foaming at the mouth, etc.), or are placed in a situation where they cannot maintain surface and core temperatures necessary to their well-being. Desert tortoises shall be kept shaded at all times until it is safe to release them. For the purposes of this permit, ambient air temperature shall be measured in the shade, protected from wind, at a height of 2 inches (5 centimeters) above the ground surface.

e. Tortoises may be removed by hand from cover sites, by using a mirror to attract their attention, and by tapping (Medica, P.A. 1986. Tapping: a technique for capturing tortoises. Herp. Review 17:15-16). Care must be taken to avoid damage to the cover site, the cover site mound, entrance to the cover site, and to avoid excessive stress to the tortoise. Juvenile tortoises are especially sensitive to disturbance and are best caught when outside their cover sites or by tapping with a small stick or grass stem.

f. Desert tortoises shall not be transported by vehicle from the capture site unless instructed or authorized to do so by the DTRO. Desert tortoises shall never be placed in automobile trunks, on floorboards in an unconfined manner, in the bed of a truck over the exhaust system, or left unattended in vehicles.

g. Numbered tags and stakes that are used to mark desert tortoise burrows or other cover sites, or vegetation sampling locations, shall not consist of highly reflective material, and the tags shall be placed in an inconspicuous location. If marked desert tortoise burrows or other cover sites have not been used for a period of 3 or more years, the tags and stakes shall be removed and disposed.

h. The permittee shall limit vehicle use to existing routes that are designated as being open to vehicle use. Within desert tortoise habitat and during times when desert tortoises are likely to be active, the permittee and individuals on the List shall not operate motor vehicles in excess of 25 miles per hour on dirt roads, and they shall watch for and avoid all desert tortoises on the road.

i. Individual desert tortoises may be marked by one or both of the following methods:

   i. Tortoise identification numbers printed on paper or sticky labels or floy tags may be epoxied onto the shell.

   ii. Notches may be filed in marginal scutes. All notches will be filed with a sharp, triangular file. Files will be replaced as they get dull or begin to rust (due to bleach used for disinfection). Notches will be filed deeply, but not so deeply as to scar the bone. As much as possible, notches will be placed on the anterior or posterior portions of the scute to minimize impacts to the bone sutures.

j. Radio transmitters shall be attached to desert tortoises similar to the manner described in Boarman *et al.* (1998. Review of radio transmitter attachment techniques for turtle research and recommendations for improvement. Herp. Review 29:26-33). Radio transmitters and antennae must be mounted so as not to impede growth or the daily activities of the desert tortoise such as burrow construction, righting of overturned desert tortoises, and mating. The permittee has the responsibility to ensure that the well-being of the desert tortoise is not compromised by either the process of attaching radio transmitters or the location and operation of these devices.

   i. Placement and installation of radio antennae on desert tortoises shall be done in a manner that eliminates voids between the carapace and the antennae (i.e., the antennae attachment shall be flush with the carapace). Antennae may be left trailing unattached behind the tortoise.

ii. The total mass of the instrumentation that is attached to each desert tortoise including antenna, epoxy, etc., shall not exceed 5 percent of the animal's body mass.

iii. Radio transmitters that contain weak batteries shall be removed or replaced before the batteries are likely to fail.

iv. Radio transmitters may temporarily (up to 48 hours) be attached to desert tortoises with duct tape, in situations in which full processing cannot be completed to comply with temperature guidelines in 8(c) above, or when light levels do not allow for processing.

v. Any shell damage from attachment or removal of radio transmitters shall be reported in writing within 3 working days to the DTRO.

vi. Adult transmittered desert tortoises shall be monitored at least monthly (year-round) to ensure that animals are not lost due to long-range movements beyond the area capable of being detected by telemetry equipment. Monitoring monthly is important even during the inactive period (when an animal is brumating). This will facilitate recapture in the spring when the desert tortoise first exits its burrow. If a desert tortoise has a malfunctioning transmitter it can be replaced before the animal becomes active. Juvenile tortoises with shorter life-span transmitters than those used on adults shall be monitored at least once a week during the active season.

vii. The permittee shall ensure that transmitters and other equipment are removed from all desert tortoises that can be located prior to the expiration date of this permit. In addition, the permittee shall exercise the best possible effort to locate and remove non-functioning transmitters and other equipment from all desert tortoises. This effort shall include thorough searches of each desert tortoise home range and previously occupied shelter sites. All efforts to locate such desert tortoises shall be documented within the annual and final reports described below, by an estimate of the number of hours spent or areas covered while searching for desert tortoises with non-functioning transmitters and other equipment. Deviation from these conditions requires prior written approval from the DTRO.

viii. The permittee may arrange, with the approval of the DTRO, to administratively transfer radio-telemetered desert tortoises to another individual permitted by the Service to telemeter desert tortoises. The permittee shall provide evidence to the Service that another permit holder has agreed to accept responsibility for transmitter maintenance and removal. The responsibility for transmitter removal applies to all

permittees authorized to attach devices to desert tortoises and to all permittees that accept this responsibility from other permittees.

k. The permittee is authorized to collect blood from the subcarapacial sinus or brachial or femoral vein to assess disease status as follows:

i. Blood samples may be collected between the months of April and October. Tortoises with "suspect" ELISA test results may be re-sampled within the same month.

ii. For tortoises greater than or equal to 180 millimeters carapace length, the maximum amount of blood that will be collected from the brachial or femoral vein or subcarapacial sinus will be 2.0 cubic centimeters (total volume of all fluids) per sample.

iii. For tortoises less than 180 millimeters carapace length, the maximum amount of blood (total volume of all fluids) per sample that will be collected from the brachial vein or subcarapacial sinus will be calculated according to the October 2007 protocol for bleeding juvenile tortoises developed for this project or other updated protocol approved by the DTRO (Attachment 1).

iv. If the amount of blood that is drawn from an individual desert tortoise is more than what is required to address the three factors identified in the permittee's study proposal, this blood shall be archived and only used for the specific purposes that have been approved in writing by the DTRO. The facilities that archive unused blood shall only make such samples available to entities as approved or directed by the DTRO.

v. Tissues, blood, or other samples to be shipped to laboratories for analysis shall be accompanied by a copy of this permit to validate that the specimens were taken pursuant to a permit.

9. The number of tortoises allowed to be incidentally injured or killed during activities conducted pursuant to this permit is zero in any calendar year, including any mortality or injury suspected as a result of any part of the study methodology (i.e., coyote/raven depredation because radio transmitters increase desert tortoise visibility, etc.). In the event that an individual is injured or killed during the performance of permitted activities, the permittee must:

a. Immediately cease the activity resulting in injury or death until reauthorized by the DTRO, which may, after analysis of the circumstances of mortality or injury, revoke or amend this permit.

b. Immediately notify the DTRO and the Region 8 Recovery Permit Coordinator (telephone: 760-431-9440; fax: 760-930-0846). The permittee must follow up verbal notification in writing within 3 working days. For Arizona, this written

report shall also be sent to the Arizona Game and Fish Department (Attention: Melissa Swain), 5000 W. Carefree Highway, Phoenix, AZ 85086 (telephone: 623-236-7625). For California, this written report shall also be sent to the California Department of Fish and Game (CDFG), Attention: Permit Biologist, Wildlife Branch, 1812 Ninth Street, Sacramento, California 95811 (telephone: 916-445-3764). For Nevada, this written report shall also be sent to the Nevada Department of Wildlife, 4747 Vegas Drive, Las Vegas, Nevada 89108 (telephone: 702-486-5127 x3718).

With the written notification, the permittee shall include a report of the circumstances that led to the injury or mortality. A description of the changes in activity protocols that will be implemented to reduce the likelihood of such injury or mortality from happening again should be included, if appropriate. The incident shall also be discussed in the annual report that is subsequently submitted.

c. Preserve any dead specimens in accordance with standard museum practices. Before expiration of the permit, all preserved specimens will be properly labeled and deposited with the designated depository. The permittee shall supply the depository with a copy of this permit to validate that the specimens were taken pursuant to a permit.

10. Designated depositories:

The Wildlife and Fisheries Museum, University of California, Davis, California; the Museum of Vertebrate Zoology, University of California, Berkeley, California; or the DTRO may approve other depositories.

11. Annual reports:

a. An annual report of activities shall be submitted in *electronic* format to the DTRO by January 31, following each year this permit is in effect. The annual report shall contain the following sections and information for each separate project/site implemented during the calendar year: (i) an abstract; (ii) an introduction section addressing reasons and objectives for taking the species; (iii) a methodology section addressing data collection and analysis procedures; (iv) a results section that summarizes the data collected, including numbers of tortoises handled and/or salvaged, carcasses collected, biological samples collected, as well as preliminary analyses; and (v) a conclusion section that specifically provides recommendations for recovery of the species.

b. In each annual report, the permittee shall provide a table that includes an estimate (to the nearest 0.2 cubic centimeters) of the volume of unused blood and serum that remains from the sample(s) collected from individual desert tortoises, after the sample(s) was/were used to provide material to determine disease status, stress levels, and genetic characteristics. For each sample of unused blood, the table will

also include: (i) a unique identifier number for the desert tortoise that blood was drawn from; (ii) the date the blood was collected; and (iii) the name of the facility where the unused blood or serum is stored. Each annual report will also quantify the number of skeletal remains that were collected during the prior year, and identify the facility where those remains are archived.

c. Each annual report shall also include, but not be limited to: (i) maps or other appropriate figures depicting the location of the study site; (ii) the numbers and location of tortoises that may have died each year; (iii) if animals voided their bladder when handled; (iv) other pertinent observations made during sampling efforts regarding the status or ecology of the species; and (v) the status of all transmittered tortoises.

d. An Excel spreadsheet and metadata document for radio transmitter information is located on the Ventura Fish and Wildlife Office website at: http://www.fws.gov/ventura/speciesinfo/protocols_guidelines/. The geographic coordinates that shall be provided in the spreadsheet shall be in a Universal Transverse Mercator projection, NAD-83 datum, and the units shall be in meters. These records shall be submitted with the annual report to the DTRO. Please return the completed Excel form to Roy Averill-Murray in the DTRO via e-mail at roy_averill-murray@fws.gov.

e. If no activities occurred over the course of the year, indication of such shall be submitted as an annual report.

12. Failure to comply with reporting requirements may result in the non-renewal or suspension/revocation of this permit.

3/22/10
Date

Michael M. Long
Endangered Species Division Chief

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825-1846

LIST OF AUTHORIZED INDIVIDUALS
TE-195280-1

1. Individuals authorized to conduct all activities pursuant to this permit, with the exception of blood sampling, are:

   Michael Tuma, Scott Hillard, John Hillman, Paula Kahn, Ken Nagy, Matthew McMillan, and Rebecca Kipp.

2. Individuals authorized to collect blood samples from tortoises via subcarapacial venipunture:

   Michael Tuma, Scott Hillard, John Hillman, Paula Kahn, and Ken Nagy.

3. Individuals authorized to collect blood samples from tortoises via brachial or femoral venipunture:

   Paula Kahn. Matthew McMillan may be authorized to conduct this activity under the direct supervision of Paula Kahn or independently upon notification by Dr. Kahn of Mr. McMillan's qualifications.

4. Individuals authorized to collect nasal lavage samples:

   Michael Tuma and John Hillman.

5. Individuals authorized to handle, weigh, measure, radio-track, and observe desert tortoises are:

   Daniel Essary, Brenda Hanley, Abraham Role, and Brent Sparks.

Supervised individuals may conduct activities pursuant to this permit only under the direct, on-site supervision of the appropriate above-named authorized individual.

3/22/10
Date

Michael M. Long
Endangered Species Division Chief

This List is valid only if it is dated on or after the permit issuance date.

Protocol for Bleeding Juvenile Tortoises

K.H. Berry (October 2007)

This protocol was developed from correspondence by electronic mail with Lori Wendland, DVM, Ph.D., an expert with gopher tortoises and a scientist in the Department of Infectious Diseases and Pathology, College of Veterinary Medicine, University of Florida, Gainesville.

With the gopher tortoise, Dr. Wendland generally uses the subcarapacial technique only when necessary. She and her team have been successful with drawing blood from the brachial vein, even in very small tortoises. However, our case with the Ft. Irwin juveniles is different, because they are highly likely to have experienced water and nutritional deficits during the last year. They are probably dehydrated, and the subcarapacial venipuncture site would likely be the more successful site.

The following procedure is sequential:

1. The pen(s) will be watered by DPW staff, hopefully causing the tortoises to emerge and drink at the base of poles and elsewhere. Emergence with artificial watering should reduce human trampling of the pens. During or shortly after watering, a few individuals will enter the pens with containers, Sharpies, and pin flags. They will collect the tortoises, put them in containers (labeled on-site with the tortoise identification number), and remove them from the pen to the processing area. A pin flag with the tortoise identification number will be written onto the flag itself and the quadrat in the pen (or similar identification) will be noted on the container and journal sheet. The pin flag will be placed at the collection point of the tortoise.

2. Each tortoise should be processed for length and weight, photographed, and data collected on the health evaluation data sheets. Look closely for chews by rodents in the axillary and inguinal areas.

3. The tortoise will be hydrated in the containers with its identification number.

4 Based on the length and weight measurements, the maximum amount of blood that can be safely drawn will be noted using the information below. I have summarized calculations below, based both on what Dr. Wendland has provided and using measurements of length and weight in Berry et al. 2002 (Deaths of desert tortoises following periods of drought and research manipulation). The amount varies by size class and should be easy to follow.

The calculations in Table 1 (next page) are based on the following equation:

Maximum blood draw (ml) = Body Weight of tortoise to be bled (kg) x 1000 g/kg x estimated 6% blood volume x 10%

5. After blood draw and, where appropriate, the nasal lavage, the tortoise will be rehydrated again.

6. The tortoise will be returned to the pen to the point of capture and the pin flag removed for use with another tortoise.

7. The tortoise will be checked within a few hours to determine if it has moved (returned to cover site). If it does not return to its cover site or a cover site, that should be noted. Someone should be keeping track of these behaviors, as they indicate poor condition.

Table 1. Amounts of blood that may be drawn from small tortoises by carapace length at the midline (mm, MCL.

Size of tortoise (mm, MCL)	Amount of blood to be drawn (ml)
< 80*	0.15–0.25, with the upper level more desirable. For the 45 g tortoise, the lower number must be used.
80–100	0.5–0.6
>100–140	0.6–1.0
>140–179	>1.0–2.0

*Call me if the weight of the tortoise, after hydration, falls below the 95% confidence interval on Figure 3a (pg. 442) of Berry et al, "Deaths of desert tortoises following periods of drought and research manipulation."

Specifications on special equipment to be used

1. You should use the 25 gauge needles (most are 5/8"), and the microtainers **without** the clay separators.
2. The small calipers and scales should be used.

Other recommendations:

1. Read the Berry et al. paper and the protocol before starting work. Pay close attention to clinical signs for dehydration and starvation, e.g., muscle wasting, lethargy, sunken eyes, closed eyes, low weights, spending the night outside a cover site, failure to seek cover at night. Be careful to record all details. Take notes on where the tortoise was in the pen at the time of capture. Does it have a burrow? Are several bunched together trying to use a single cover site?

2. **CRITICAL.** Use the small calipers and the small weights; **get accurate weights prior to rehydration, then after as well. Make notes on these weights on page 1 of the data sheet.**

3. For the very small tortoises, do not try the nasal lavage.

4. There are about 75 containers (new) with lids. In addition, there is a package of new paper bowls, which will be useful for the very small tortoises (40-55 mm MCL). You can write the identification numbers of the tortoise on these containers with the Sharpie, and the container should stay with the tortoise. You may wish to write the pen number, as well as the quadrat within the pen.

5. Practice the regular disinfection procedures. Remember to disinfect containers if you re-use them. Please return them back to the lab for other uses and for re-cycling, where necessary.

ARIZONA GAME & FISH DEPT
5000 W CAREFREE HWY
PHOENIX AZ 85086

DEPT-ID : E05188449

State of Arizona
Game and Fish Commission

2009 LICENSE NUMBER SP551757 VALID 08/11/2009 THRU 12/31/2009
CLASS SCIENTIFIC COLLECTING DEALER 0001
AMOUNT PAID *** COMPLIMENTARY ***

DATE-OF-BIRTH	HEIGHT	WEIGHT	EYES	HAIR	SEX
05/05/1968	5' 11"	165	BLU	BRN	M

DATE: 08/11/2009 TIME:12:25

MICHAEL TUMA
625 FAIR OAKS AVE STE190
SOUTH PASADENA CA 91030

I hereby certify all information on this license to be true. My privilege to purchase this license has not been suspended or revoked by the Commission.

Michael W Tuma

NOT VALID UNTIL SIGNED

GF AG&F USE ONLY
193335

Arizona Game and Fish Department
Scientific Collecting Permit
Standard Notes

A) **THIS PERMIT IS VALID FOR OFFICIAL USE ONLY. USE OF THIS PERMIT FOR PERSONAL OR OTHER ACTIVITIES NOT IDENTIFIED IN PROPOSAL IS PROHIBITED.**

B) **As per A.R.S. Title 17 102 and 306, and Commission Rule R12-4-402, live wildlife, parts thereof, or their progeny, obtained or held under the authority of this license may NOT be offered for sale, traded, bartered, loaned for the purposes of commercial activity, given as a gift, or disposed of in any way except as stipulated by the Department. Live wildlife, parts thereof, or their progeny, obtained or held under the authority of this license shall remain the property of the State of Arizona. Upon completion of the licensed activity, live wildlife, parts thereof, or their progeny will ONLY be disposed of as per the direction of the Department.**

C) **This permit does not authorize activities with federally listed species nor does it authorize activities on federal or tribal lands unless appropriate federal and tribal permits are obtained. Additional permits/permission from the land owner/manager or resource management agency may be required for access and/or collecting on National Park Service, National Wildlife Refuge, National Monuments, Department of Defense, Forest Service, Bureau of Land Mgmt, State Parks, State Monuments, or private lands. In addition, permits from other states or the federal government may be required when transporting across state lines and holding live wildlife.**

D) **This permit does not authorize activities with any plants, insects, or arachnids.**

E) Specimens, including incidental take and salvage, whose collection was intended primarily for scientific study, must be deposited in a United States museum that is accredited by either the American Society of Mammalogists (Hafner et al., 1997. Journal of Mammalogy, Suppl. Vol. 78, No. 1: 1-80) or listed by the American Society of Ichthyologists and Herpetologists (Leviton et al., 1985. Copeia 1985: 802-832). Specimens whose collection was intended primarily for a teaching collection at an accredited institution may be housed at the institution where they are used. Bird specimens must be deposited at the University of Arizona or other accredited university or museum. Information on specimen deposition shall be included in the year-end collecting report.

F) The maximum number of animals that may be collected under the permit will apply to the aggregate of all collectors (permittee and agents).

G) Disperse your collection activities for all species to avoid negatively impacting local populations.

H) Use aseptic techniques to prevent the spread of pathogens in aquatic wildlife populations (e.g. http://www.jcu.edu.au/school/phtm/PHTM/frogs/field-hygiene.pdf).

I) Do not use destructive collecting techniques (e.g., destroying rock crevices, removing caprock, tearing apart deadfall, etc).

J) **Photography may only be done for non-commercial purposes.**

State of Arizona
Game and Fish Department
No refunds/Not transferable

LICENSE YEAR 2010
HQ - PHOENIX
FREE E-NEWS SIGNUP
www.azgfd.gov/signup

DEPT-ID : E05188449
DATE: 04/19/2010 9:18
RESIDENT: 00 yr 00 mo

LIC# SP640288 CLS SCIENTIFIC COLLECTING .00 VALID 04/19/2010 - 12/31/2010

BIRTH-DATE	HEIGHT	WEIGHT	EYES	HAIR	SEX
05/05/1968	5' 11"	165	BLU	BRN	M

I hereby certify all information on this license to be true.

MICHAEL TUMA
625 FAIR OAKS AVE STE190
SOUTH PASADENA CA 91030

Michael W. Tuma
NOT VALID UNTIL SIGNED

Scientific Collecting Permit Stipulations
Calendar Year 2010
SWCA Environmental Consultants
MICHAEL TUMA

1. The following are agents under this permit for the activities below: Roy Averill-Murray

   The permittee OR the agents MUST be present at all activities conducted under authority of this permit and must have a copy of the permit and stipulations present at all times while conducting activities.

2. This permit allows stipulated activities to be conducted: **in the Gold Butte-Pakoon Critical Habitat area (Mohave County).**

3. You are authorized to capture, process, take blood samples, mark (including floy tags, shell notching, and radio-telemetry), and release desert tortoises Mojave desert tortoises (*Gopherus agassizii*) in accordance with the Biological Opinion 22410-2009-F-0223 issued by the FWS AESO on May 21, 2009.

4. You must coordinate your activities with the Arizona Game and Fish Turtles Project Coordinator (Cristina Jones 623-236-7767 or cjones@azgfd.gov) prior to conducting field work. In addition to the Scientific Collecting Permit report form due prior to January 31, 2011, please also submit a copy of the annual report submitted to the USFWS and BLM.

5. Use of telemetry must be coordinated with the Department to avoid overlapping frequencies. Contact the Research Branch (928-210-7497) to coordinate activities.

END

Arizona Game and Fish Department
Scientific Collecting Permit
Standard Notes

A) **THIS PERMIT IS VALID FOR OFFICIAL USE ONLY. USE OF THIS PERMIT FOR PERSONAL OR OTHER ACTIVITIES NOT IDENTIFIED IN PROPOSAL IS PROHIBITED.**

B) **As per A.R.S. Title 17 102 and 306, and Commission Rule R12-4-402, live wildlife, parts thereof, or their progeny, obtained or held under the authority of this license may NOT be offered for sale, traded, bartered, loaned for the purposes of commercial activity, given as a gift, or disposed of in any way except as stipulated by the Department. Live wildlife, parts thereof, or their progeny, obtained or held under the authority of this license shall remain the property of the State of Arizona. Upon completion of the licensed activity, live wildlife, parts thereof, or their progeny will ONLY be disposed of as per the direction of the Department.**

C) **This permit does not authorize activities with federally listed species nor does it authorize activities on federal or tribal lands unless appropriate federal and tribal permits are obtained. Additional permits/permission from the land owner/manager or resource management agency may be required for access and/or collecting on National Park Service, National Wildlife Refuge, National Monuments, Department of Defense, Forest Service, Bureau of Land Mgmt, State Parks, State Monuments, or private lands. In addition, permits from other states or the federal government may be required when transporting across state lines and holding live wildlife.**

D) **This permit does not authorize activities with any plants, insects, or arachnids.**

E) Specimens, including incidental take and salvage, whose collection was intended primarily for scientific study, must be deposited in a United States museum that is accredited by either the American Society of Mammalogists (Hafner et al., 1997. Journal of Mammalogy, Suppl. Vol. 78, No. 1: 1-80) or listed by the American Society of Ichthyologists and Herpetologists (Leviton et al., 1985. Copeia 1985: 802-832). Specimens whose collection was intended primarily for a teaching collection at an accredited institution may be housed at the institution where they are used. Bird specimens must be deposited at the University of Arizona or other accredited university or museum. Information on specimen deposition shall be included in the year-end collecting report.

F) The maximum number of animals that may be collected under the permit will apply to the aggregate of all collectors (permittee and agents).

G) Disperse your collection activities for all species to avoid negatively impacting local populations.

H) Use aseptic techniques to prevent the spread of pathogens in aquatic wildlife populations (e.g. http://www.jcu.edu.au/school/phtm/PHTM/frogs/field-hygiene.pdf).

I) Do not use destructive collecting techniques (e.g., destroying rock crevices, removing caprock, tearing apart deadfall, etc).

J) **Photography may only be done for non-commercial purposes.**

NEVADA DEPARTMENT OF WILDLIFE

SPECIAL LICENSE/PERMIT

Date Issued 10/5/2009 License Type Scientific Collection Permit

Name of Licensee/Permittee Tuma Michael W
(Last) (First) (Initial)

Mailing Address SWCA Environ Cnslt, 625 Fair Oaks Ave, Ste 190

Street Address - Same -

City South Pasadena State CA ZIP 91030

Tax ID/SSN 321-48-8933 Date of Birth 5/5/68 Sportsmans ID

License Class 22.92 Agent No. 1950 Issued by jgm Fee $ 100.00

License/Permit Valid From October 5, 2009 - December 31, 2011

FORM 22XX S32293

— Special Conditions —

All applicable sections set forth in the Nevada Administrative Code (NAC) and Title 45 of the Nevada Revised Statutes (NRS) shall apply.

- Authorizations and Conditions Attached –

- Period of Collection Activities: See Condition #4 –

- Activity Report(s) Due: 01/30/2011; 01/30/2012 –

JIM GIBBONS
Governor

STATE OF NEVADA
DEPARTMENT OF WILDLIFE
1100 Valley Road
Reno, Nevada 89512
(775) 688-1500 • Fax (775) 688-1595

KENNETH E. MAYER
Director

RICHARD L. HASKINS II
Deputy Director

PERMITTEE:

Michael Tuma
SWCA Environmental Consultants
625 Fair Oaks Ave Ste 190
S Pasadena CA 91030

Permit No.: S 32293
Date Issued: 10/5/2009
Date Effective: 10/5/2009
Period of Sampling: See Condition #4
Expiration Date: 12/31/2011
Annual Report Due: 1/30/2011 & 1/30/2012
Fed. Permit No.: TE195280-0

SCIENTIFIC COLLECTION PERMIT NO. S 32293

In compliance with the conditions listed below and pursuant to provisions of NRS 503.597 & 503.650, the permittee, each permit year during the designated sampling period, is authorized to:

a) Salvage 60 Desert tortoises *(Gopherus agassizi)* found dead.
b) Capture, identify, collect blood sample/nasal lavage, mark with radiotransmitters and release at site taken 60 Desert tortoises *(Gopherus agassizi)*, 20 male, 20 female and 20 juvenile.

CONDITIONS:

1. A copy of this permit and any permits required by the U.S. Fish and Wildlife Service must be in the possession of the permittee and any authorized collectors while conducting collection/salvage activities. The permittee must comply with all terms, conditions and restrictions of the federal permit. This permit is invalid for the taking, collection, or salvage of migratory birds, threatened or endangered species, absent any permit required by the Service for that activity.

2. Authorized Sampling Area: BLM lands within the Gold Butte ACEC in Clark County.

   This permit does NOT authorize trespass and/or collecting activities on state or federal wildlife refuges or reserves, or other public and private property without the permission from landowner or custodian.

3 Number Authorized: Indicated above.

4. Period of Field Collection: October 5, 2009 – December 31, 2011.

5. Destination of Collection: Samples will be sent to University of Nevada Reno; Any incidental mortalities will be sent to the Museum of Vertebrate Zoology at UC Berkeley, CA

6. Annual Report: A record will be created for each specimen (or group of specimens of a single species) taken at each site-locality. "Taken" means salvaged; captured & released; collected; banded; trapped & killed; seined; netted; snared; sacrificed; reduced to possession; etc. The following information will be recorded for each specimen taken: By date, the number of specimens of each species taken; species name; the habitat type where each specimen was taken; numeric breakdown of sex whenever possible; and a description of the location where each specimen was taken, by the following method: *(Don't use common geographic names)*

   – UTM Coordinates, NAD 83, Zone 11, rounded to the nearest meter;

The records must be submitted to the Nevada Department of Wildlife, License Office – Scientific Collection Report, 4600 Kietzke Ln D-135, Reno, NV 89502, by 1/30/2011 for 2010 "take" activities; and 1/30/2012 for the 2011 "take" activities. Digital reports in Excel spreadsheet (*preferred*) or Quattro Pro are accepted (please follow column sequence as outlined in the Department report form, 22.85-5.)

7. A copy of all pertinent research or technical papers must be submitted to the Department.

8. All specimens authorized under the authority of this permit, including offspring, are property of the State of Nevada and as such, they shall not be sold, bartered, traded, converted to personal use or otherwise disposed of without written approval of the Department, except as provided in Condition #5. This condition remains in effect indefinitely.

9. No fee may be charged to the public for the privilege to view wildlife which is held under the authority of this permit.

10. Permit Cancellation: A violation of a condition or stipulation is cause for the cancellation of the permit.

11. Additional Authorized Collectors: Paula Kahn, John Hillman, Abraham Role and Brenda Hanley.

Julie Meadows
Program Officer I

jgm
enclosure

STATE OF NEVADA – DEPARTMENT OF WILDLIFE SLAP 22.85-5

SCIENTIFIC COLLECTION REPORT FORM

Submit To: Nevada Department of Wildlife, License Office, 4600 Kietzke Ln D-135, Reno, NV 89502 **NOTE:** Consult your permit for the DUE date. (Digital reports in Quattro Pro or Excel spreadsheet (*preferred*) are accepted; use column & data sequence as outlined below.)

Permittee's Name: Michael Tuma – SWCA Environmental Consultants Permit Number: S32293 Page _____ of

Date of Capture/ Collection (m/d/yy)	Species Name (*Common & Scientific Name*)	Number Taken by Method A. Salvage of dead specimens B. Live-trap, maintain live C. Sacrifice (in field or lab) *D. Capture & Release				Specify the Location of "take" by: (*-No Common Names-*) 1. UTM's, NAD 83, Zone 11 rounded to the nearest meter ,OR 2. Longitude & latitude, WGS 84, in *decimal-degrees* to 4 places (117°.2635); OR 3. Township/Range/ & *1/4* Section.	Habitat (Key on Reverse)	Number by Sex		
		A.	B.	C.	D.			M	F	Unk

* D.--Capture & Release (*includes* any banding, marking, tagging, etc.)

--Turn Over For Habitat Key--

Habitat KEY For Scientific Collection Reports

Key No.	Habitat Type
1.	Salt desert scrub
2.	Joshua tree woodland
3.	Creosote scrub
4.	Sagebrush scrub
5.	Mountain brush
6.	Yellow pine, white fir
7.	Lodgepole pine, red fir
8.	Pinyon-juniper
9.	Subalpine
10.	Alpine tundra
11.	Riparian (A=Aspen; C=Cottonwood; N=Native Hay; W=Willow)
12.	Springs
13.	Playa
14.	Marsh
15.	Urban
16.	Cave
17.	Rock Outcrop
18.	Artificial (Describe:____________________)
19.	Other (Describe:____________________)

Appendix C: Landscape and Habitat Mapping

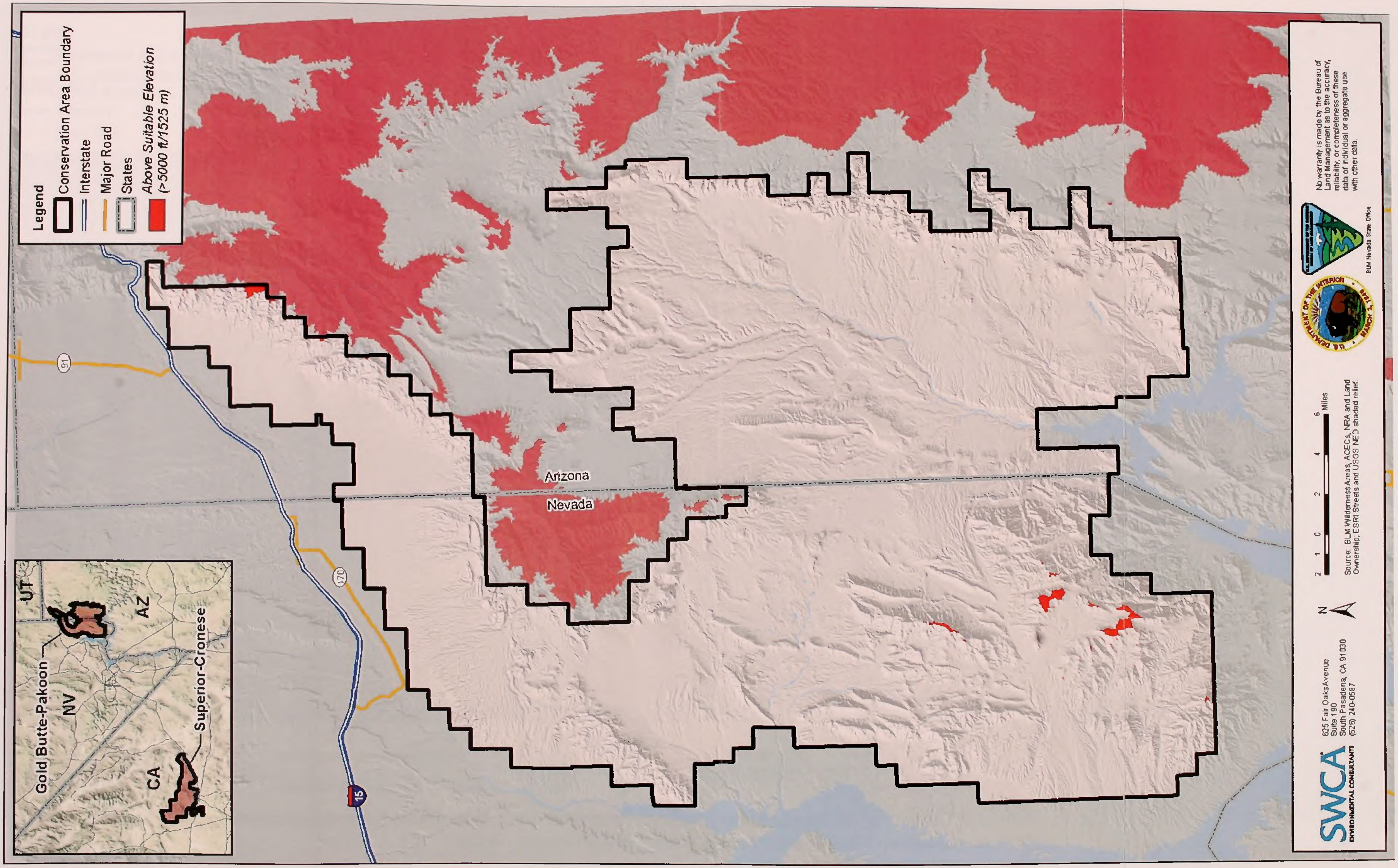

Figure C-1. Suitable Elevation Limits within the Gold Butte-Pakoon Conservation Area

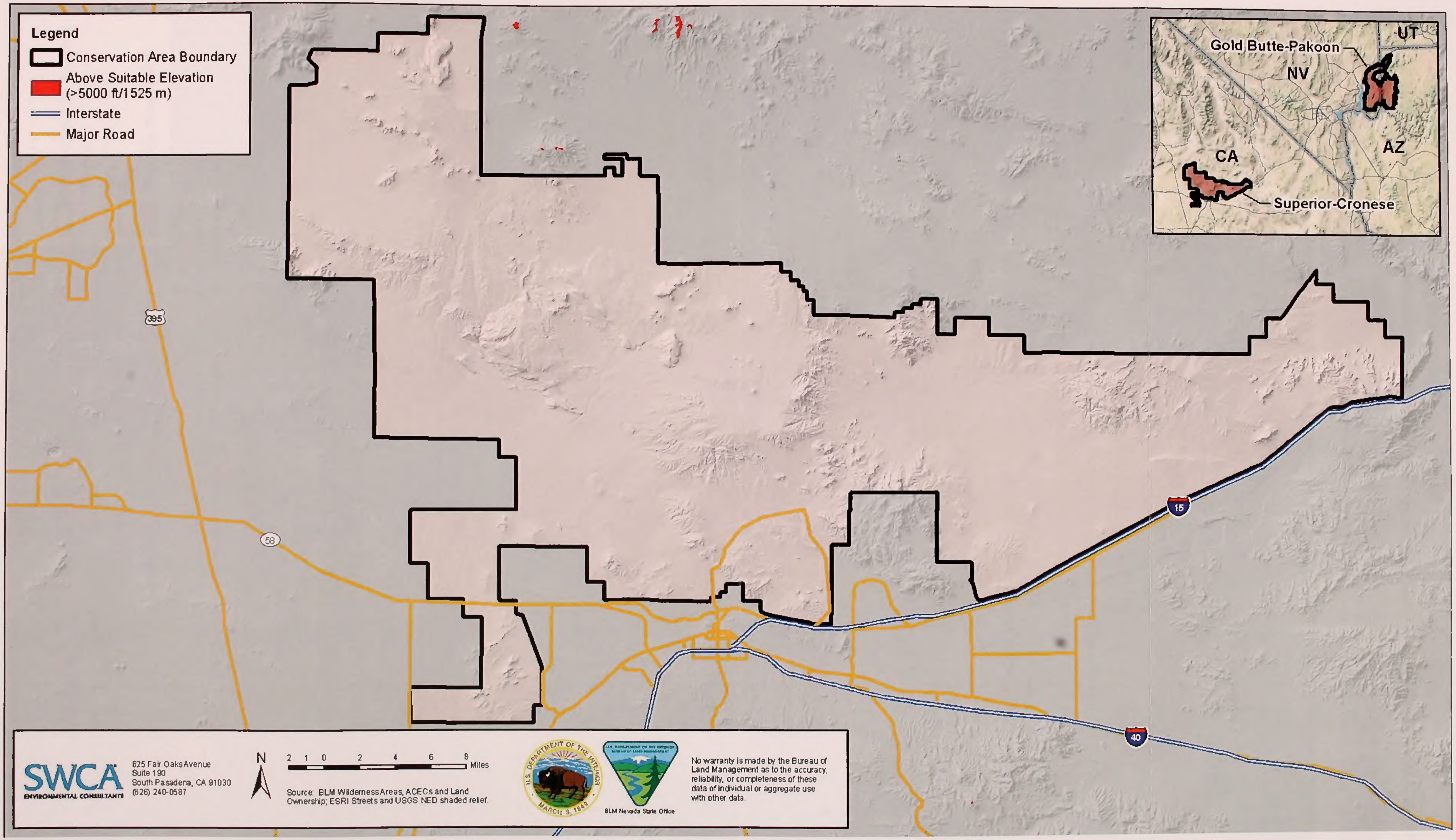

Figure C-2. Suitable Elevation Limits within the Superior-Cronese Conservation Area

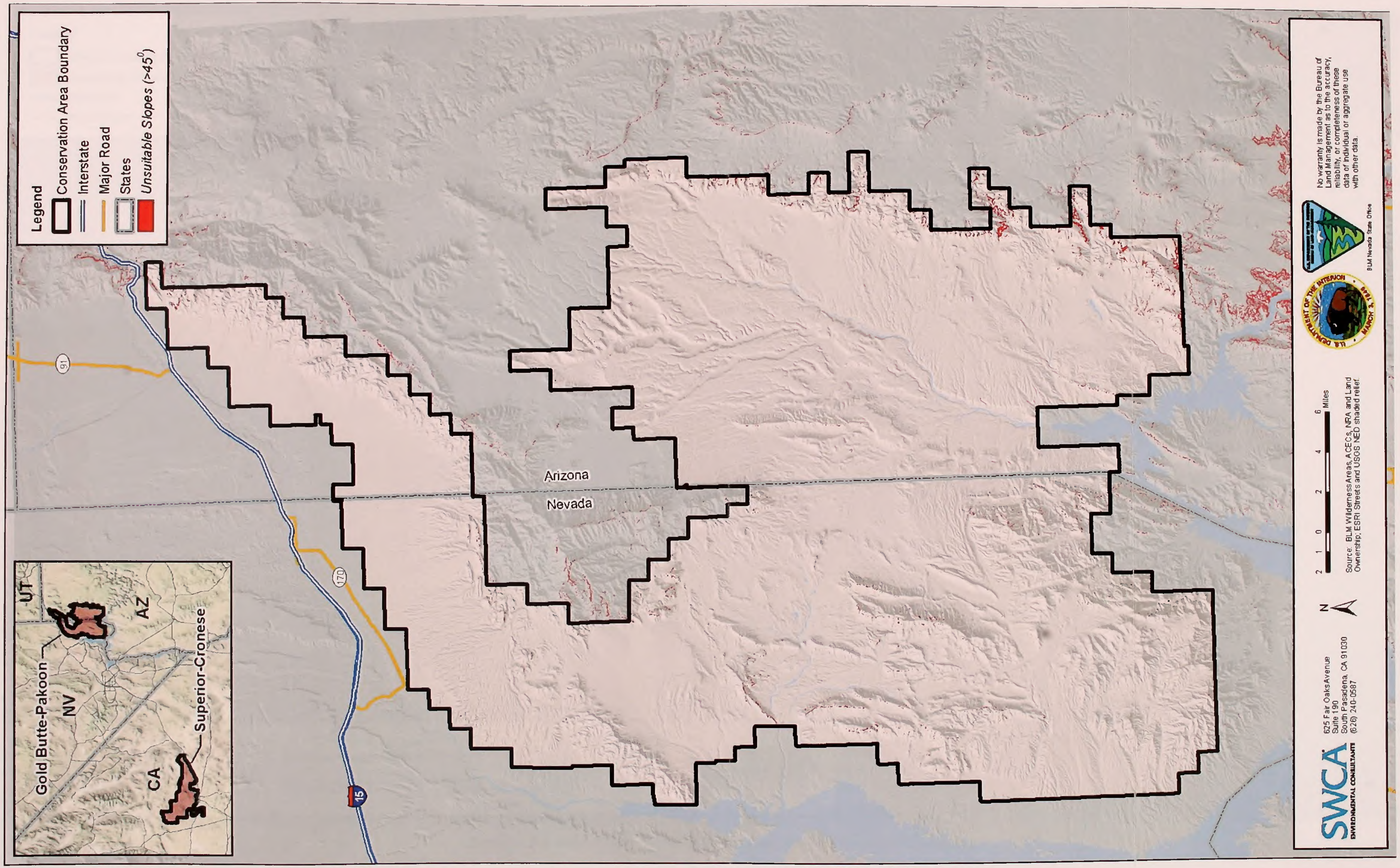

Figure C-3. Suitable Slope Limits within the Gold Butte-Pakoon Conservation Area

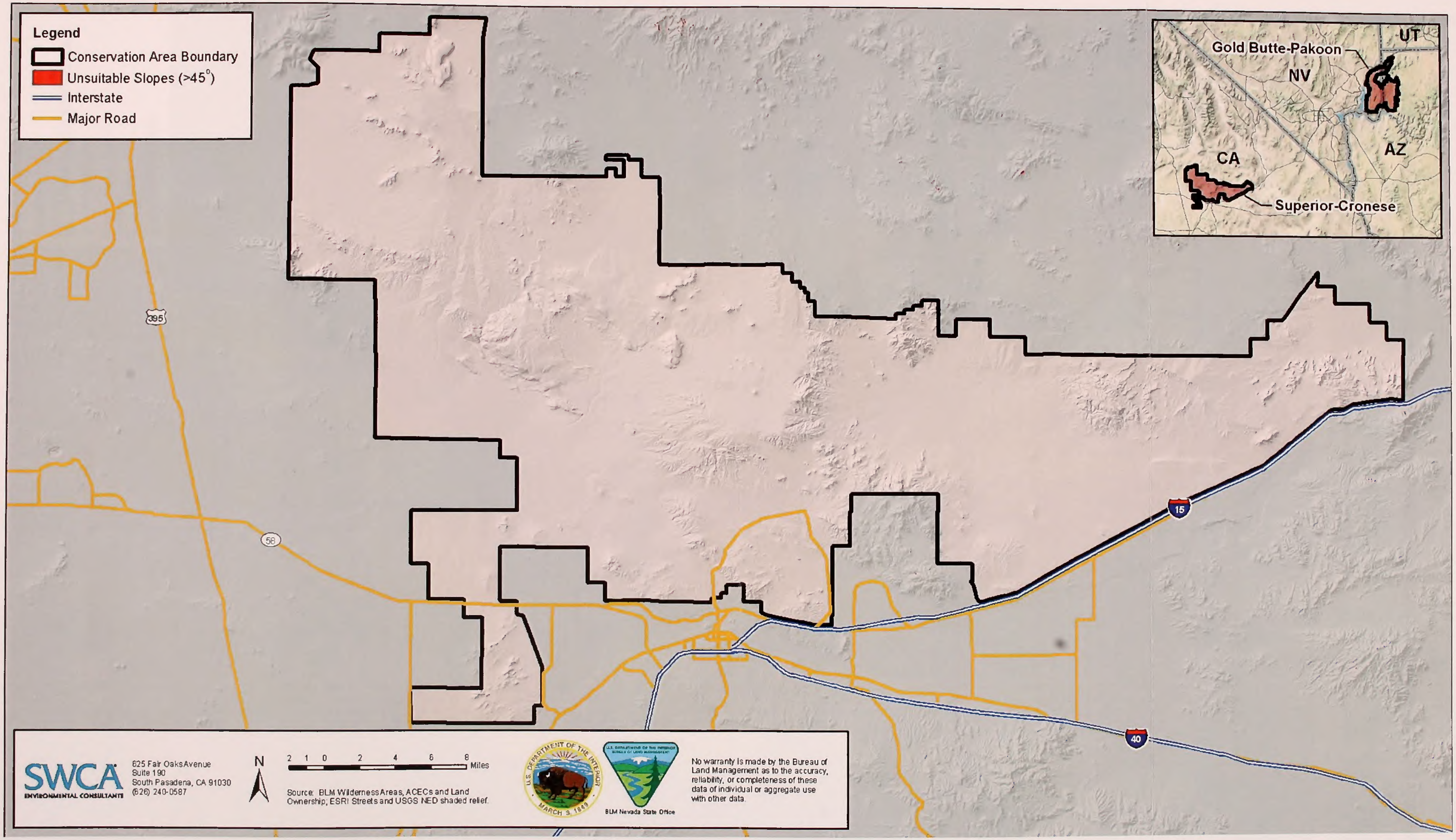

Figure C-4. Suitable Slope Limits within the Superior-Cronese Conservation Area

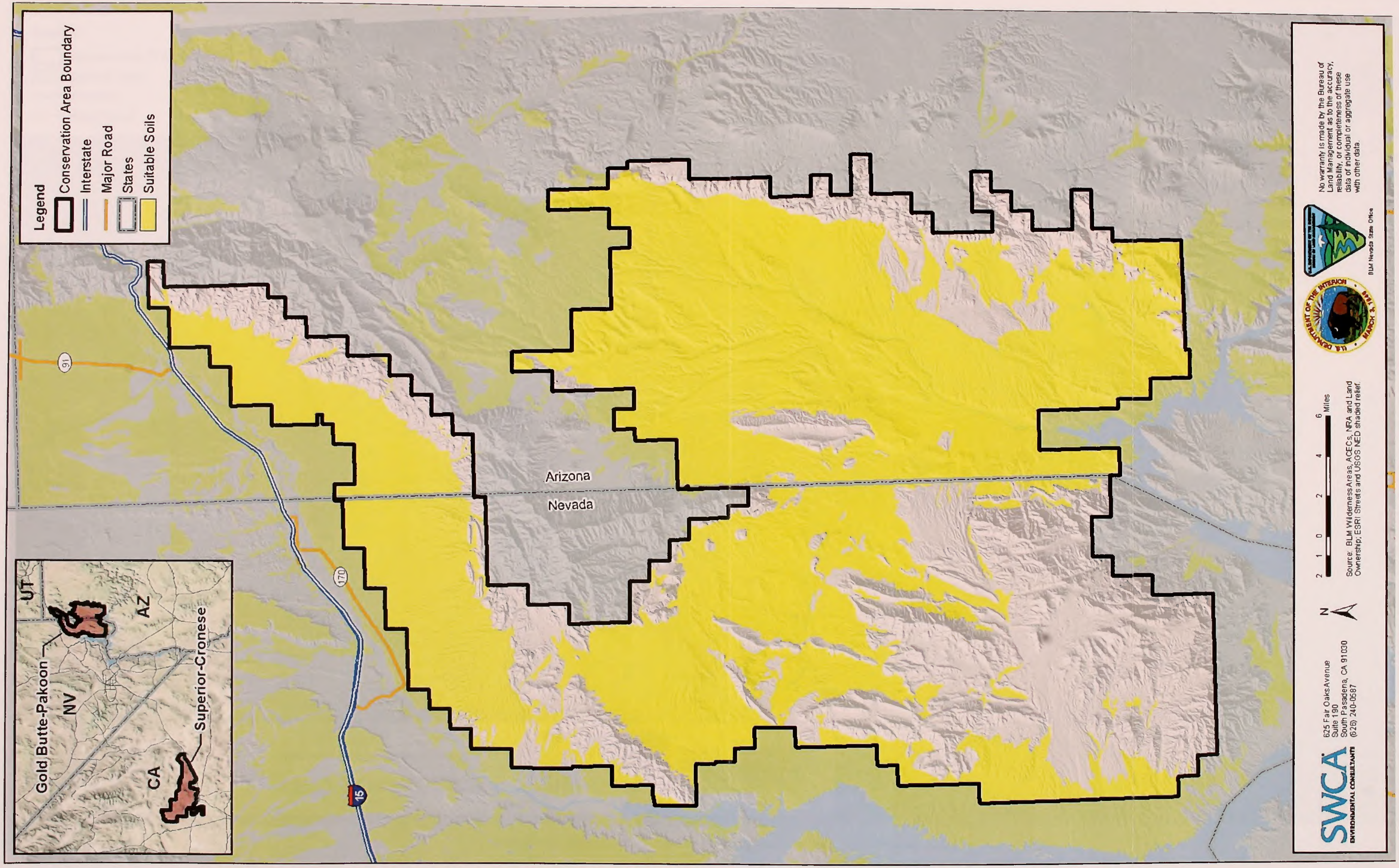

Figure C-5. Suitable Soils within the Gold Butte-Pakoon Conservation Area

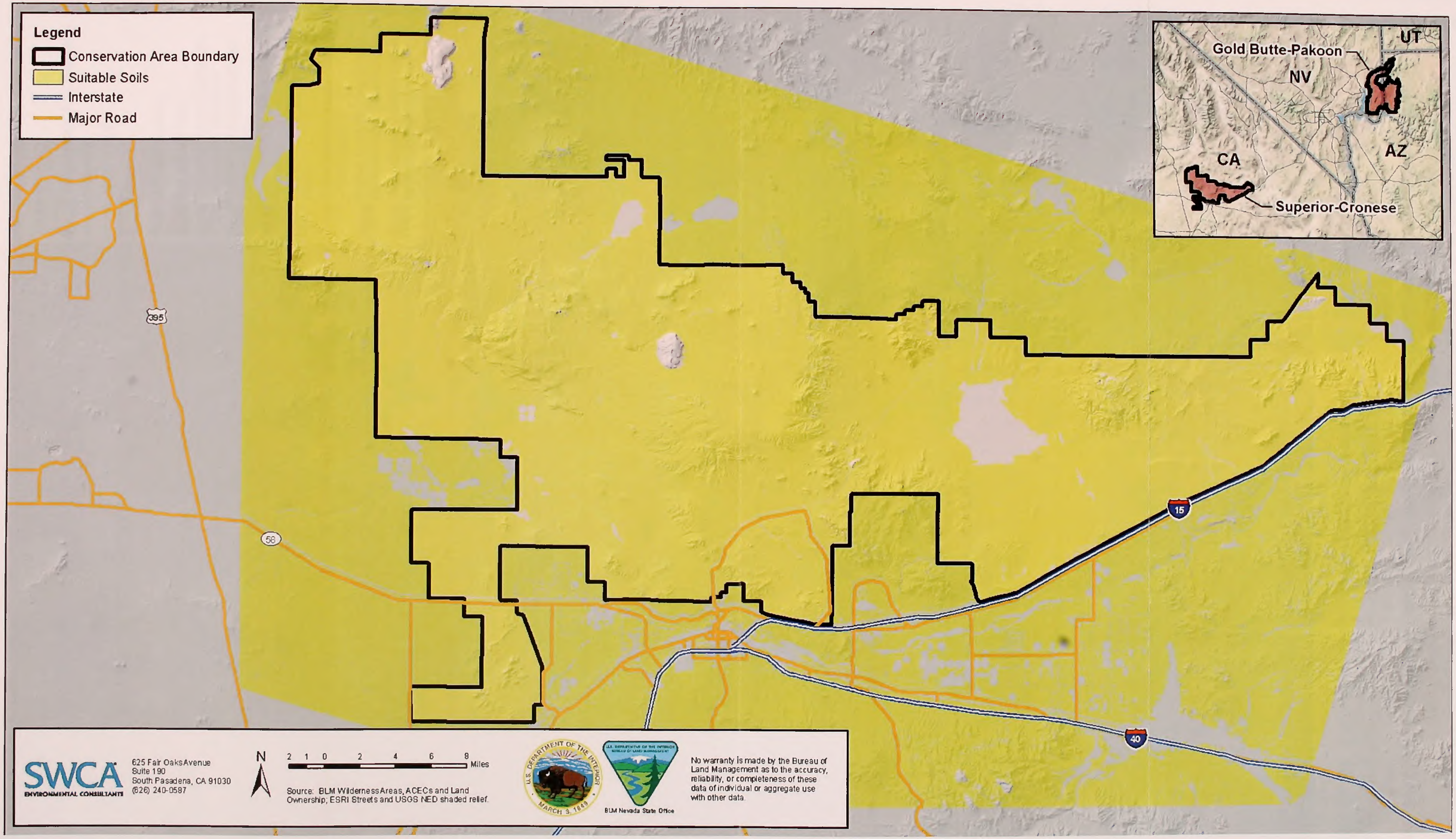

Figure C-6. Suitable Soils within the Superior-Cronese Conservation Area

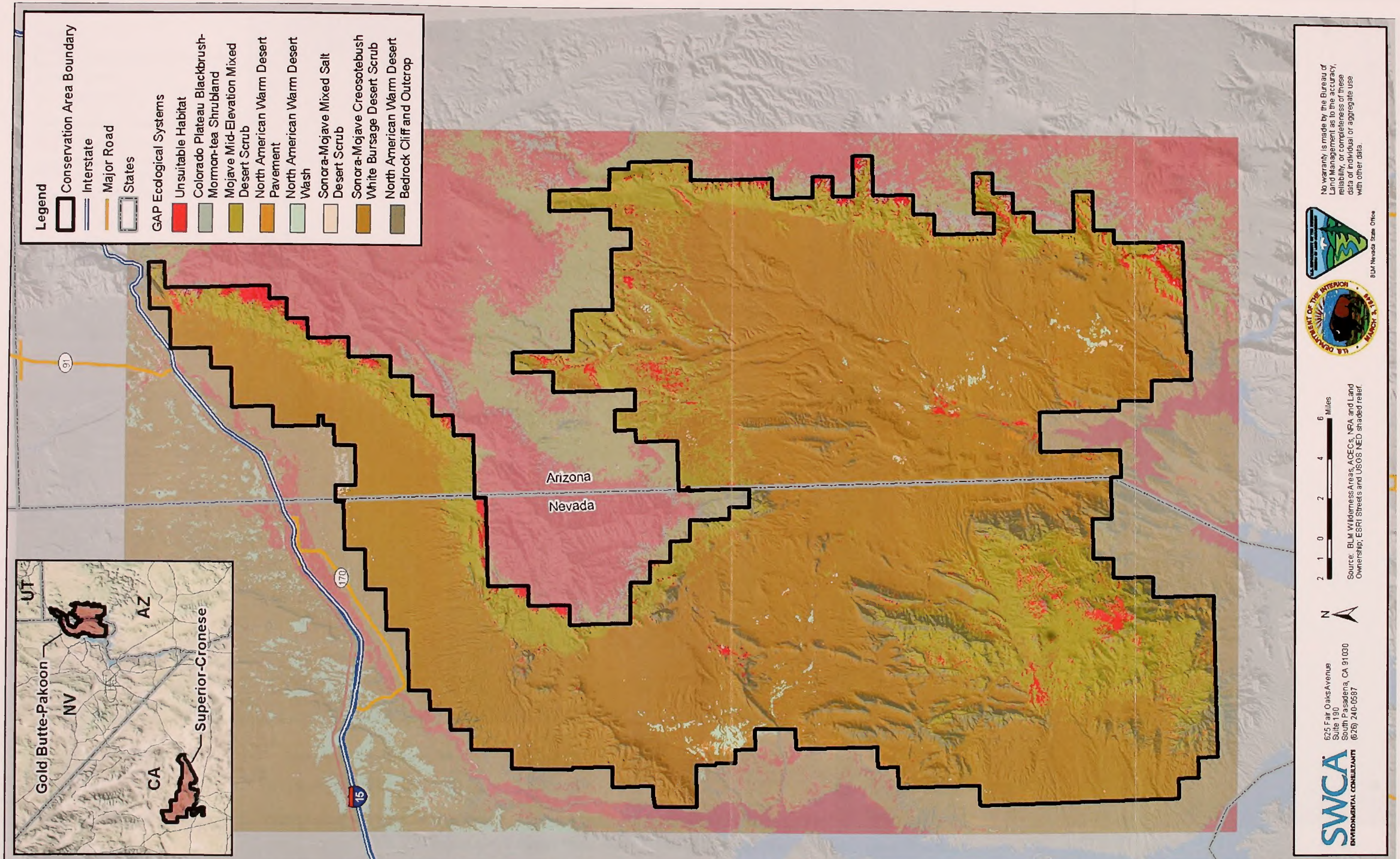

Figure C-7. Suitable Vegetation Communities within the Gold Butte-Pakoon Conservation Area

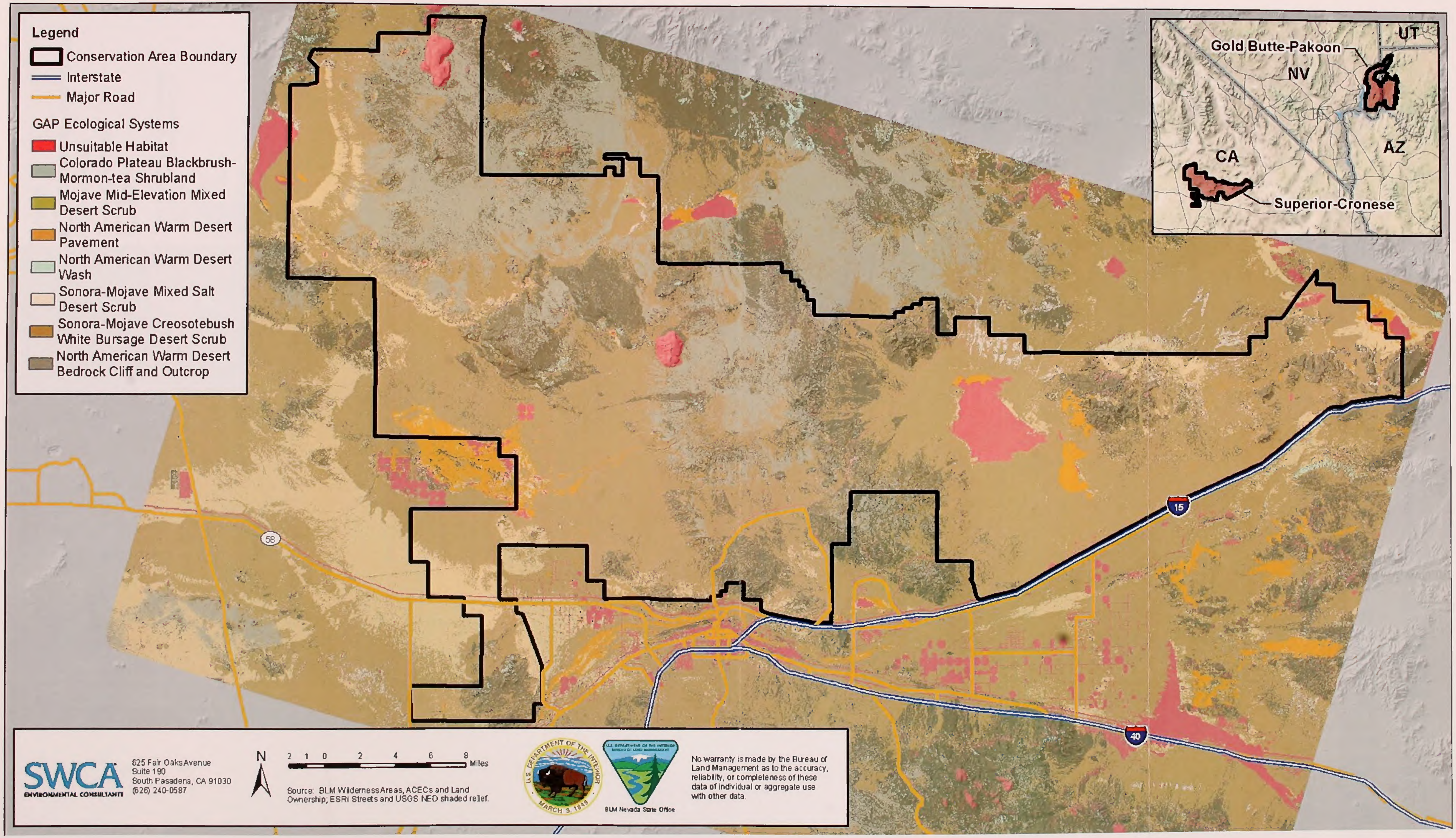

Figure C-8. Suitable Vegetation Communities within the Superior-Cronese Conservation Area

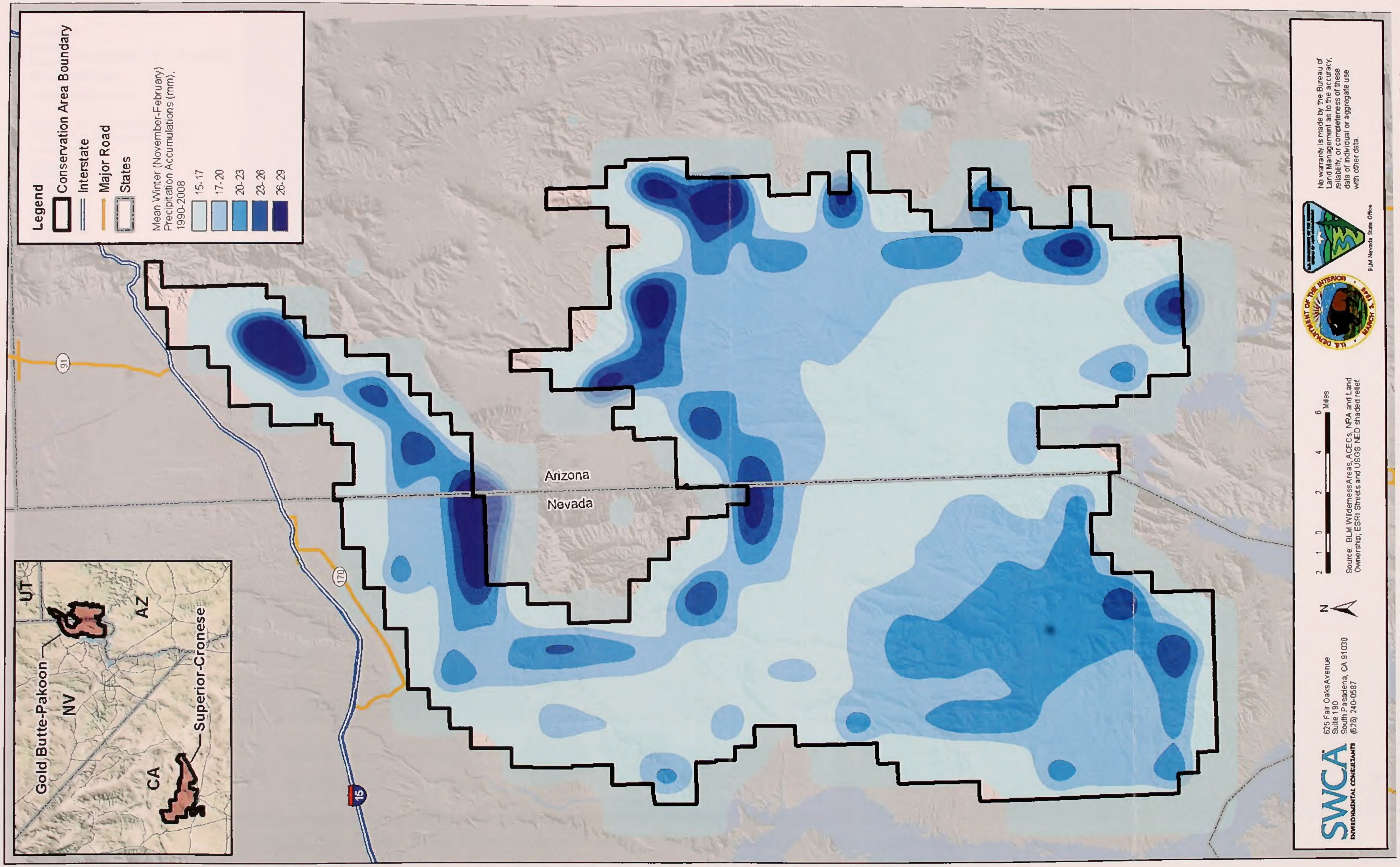

Figure C-9. Average Winter Season (November through February) Precipitation Accumulations within the Gold Butte-Pakoon Conservation Area

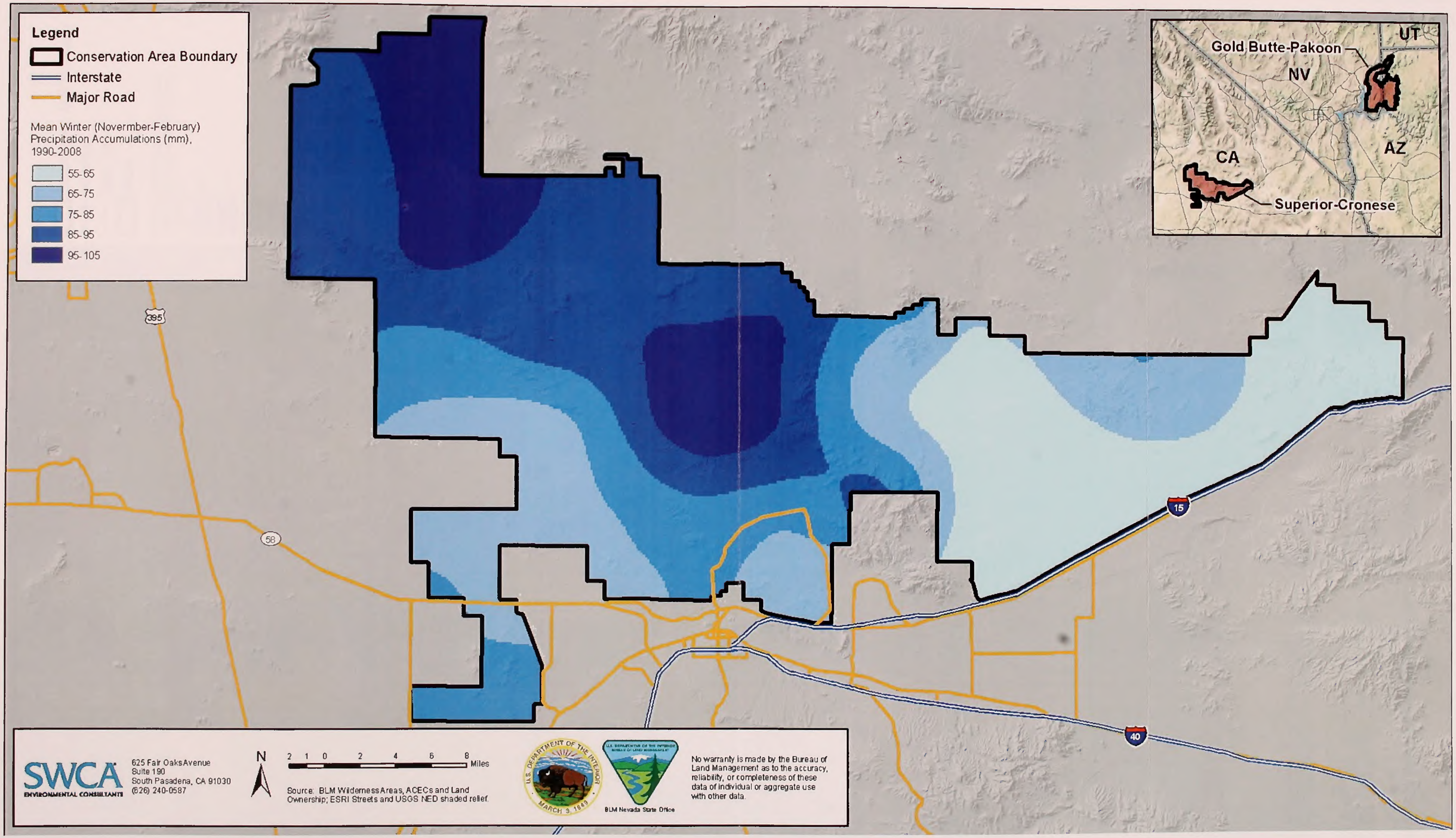

Figure C-10. Average Winter Season (November through February) Precipitation Accumulations within the Superior-Cronese Conservation Area

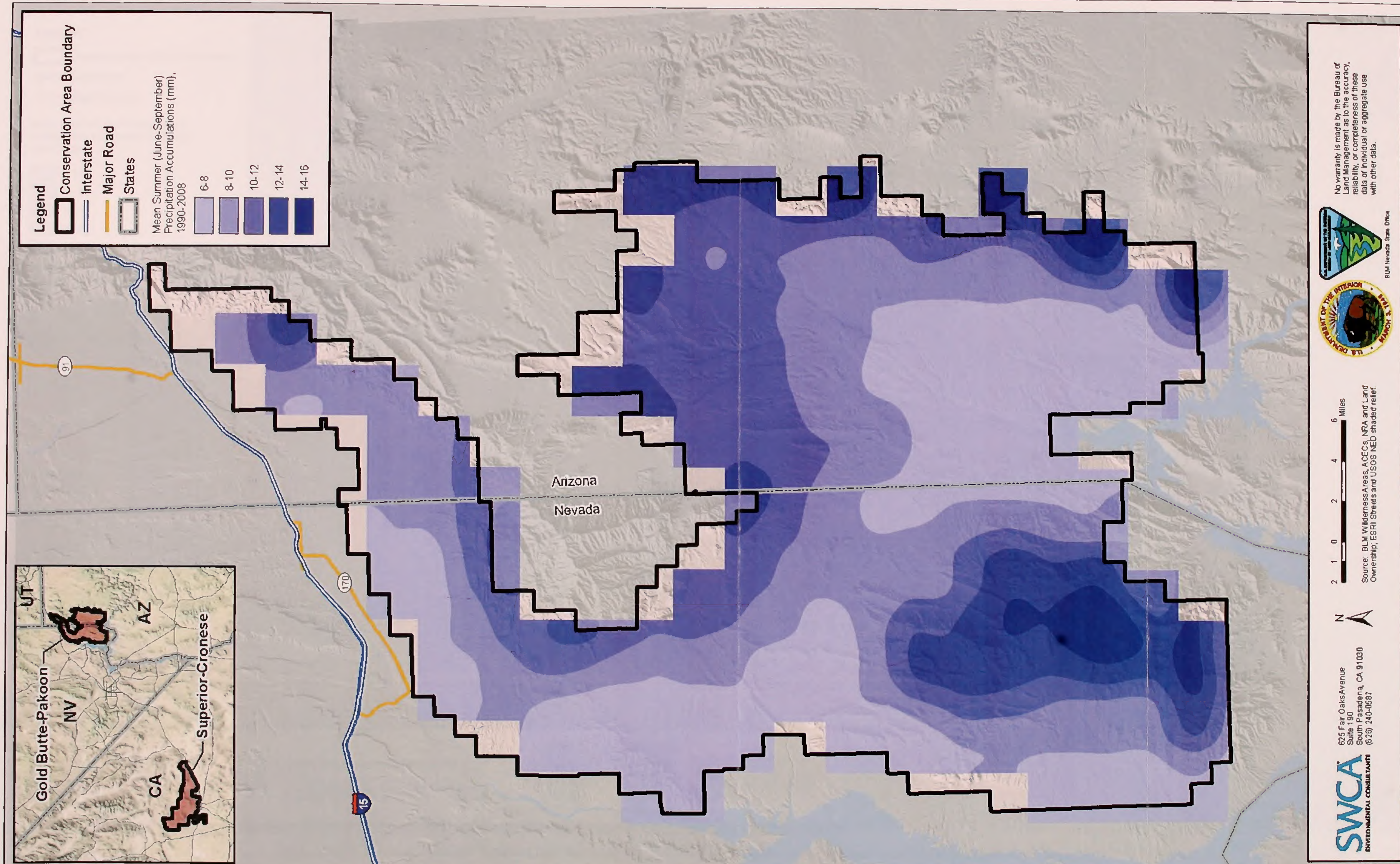

Figure C-11. Average Summer Season (June through September) Precipitation Accumulations within the Gold Butte-Pakoon Conservation Area

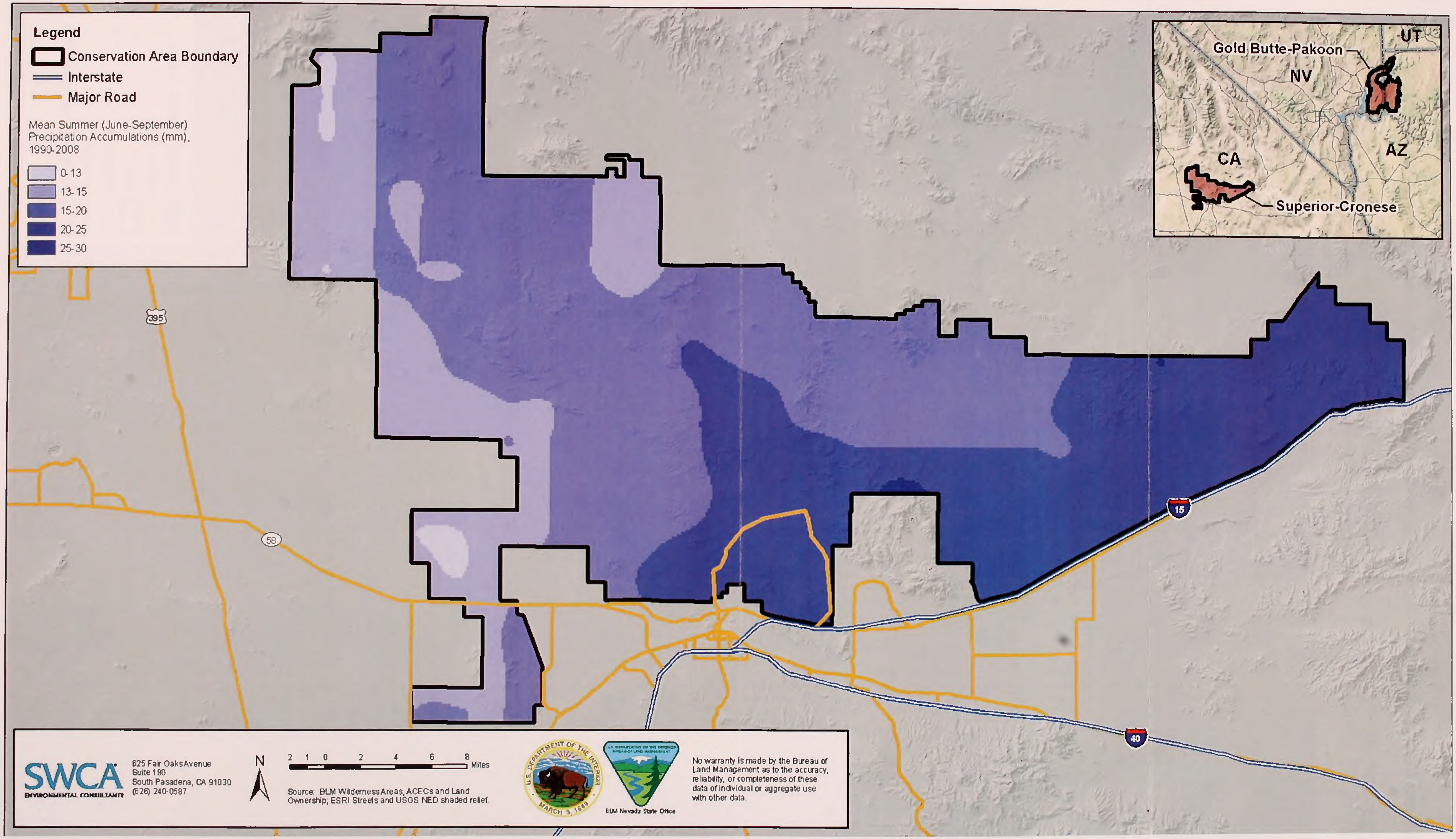

Figure C-12. Average Summer Season (June through September) Precipitation Accumulations within the Superior-Cronese Conservation Area

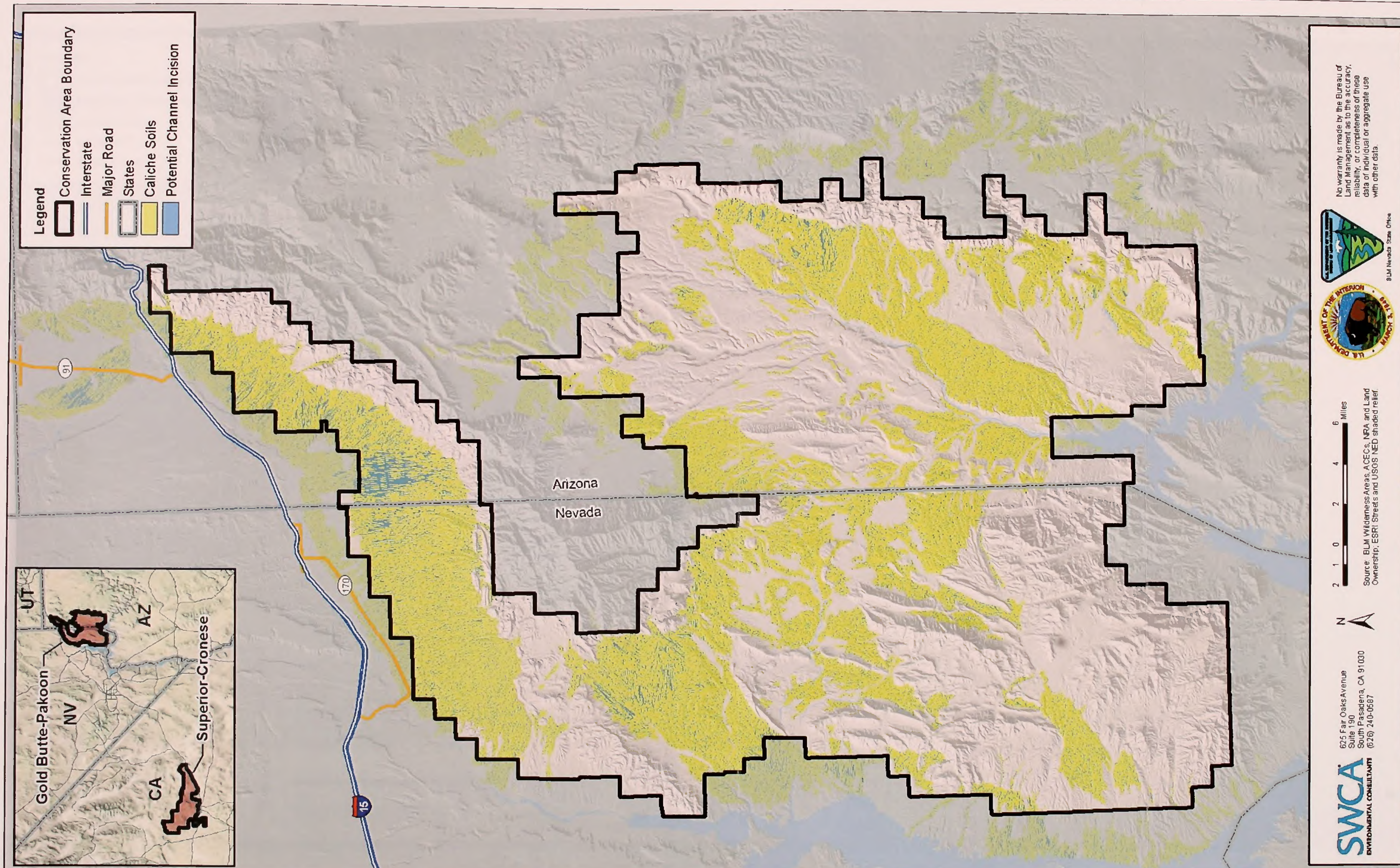

Figure C-13. Caliche Cave Potential within the Gold Butte-Pakoon Conservation Area

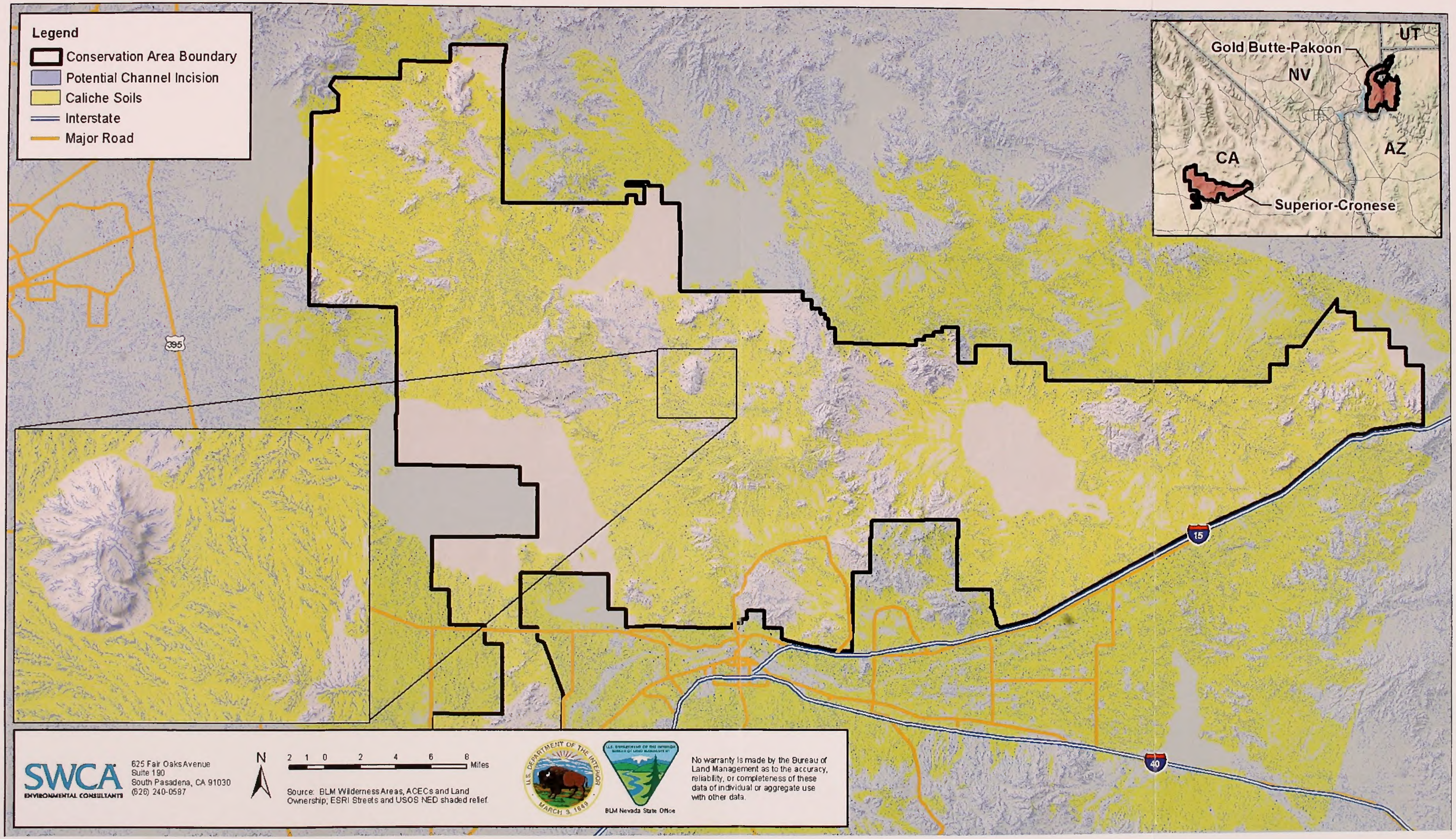

Figure C-14. Caliche Cave Potential within the Superior-Cronese Conservation Area

Appendix D: Threats Mapping

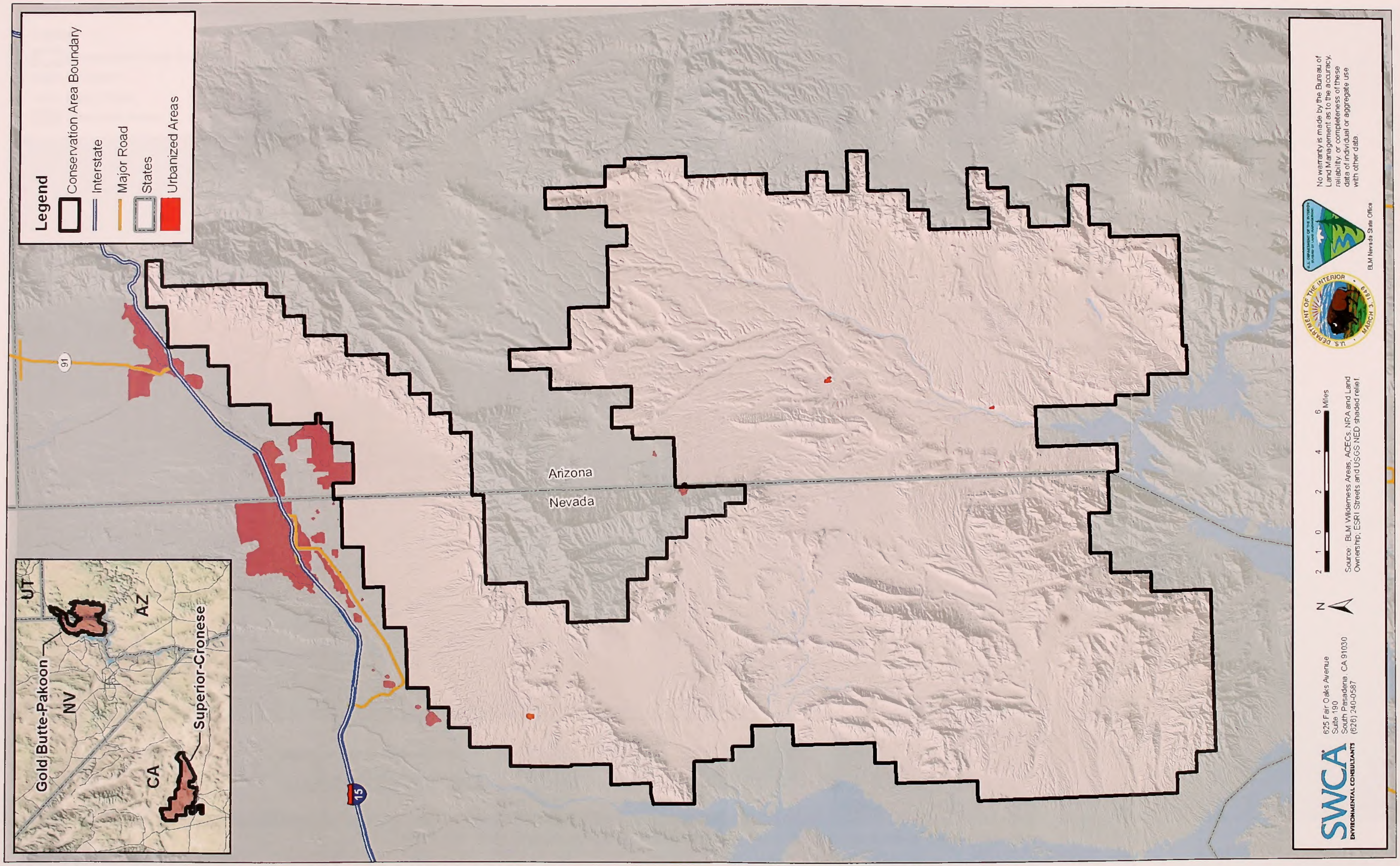

Figure D-1. Urbanized Areas Located within and Adjacent to the Gold Butte-Pakoon Conservation Area

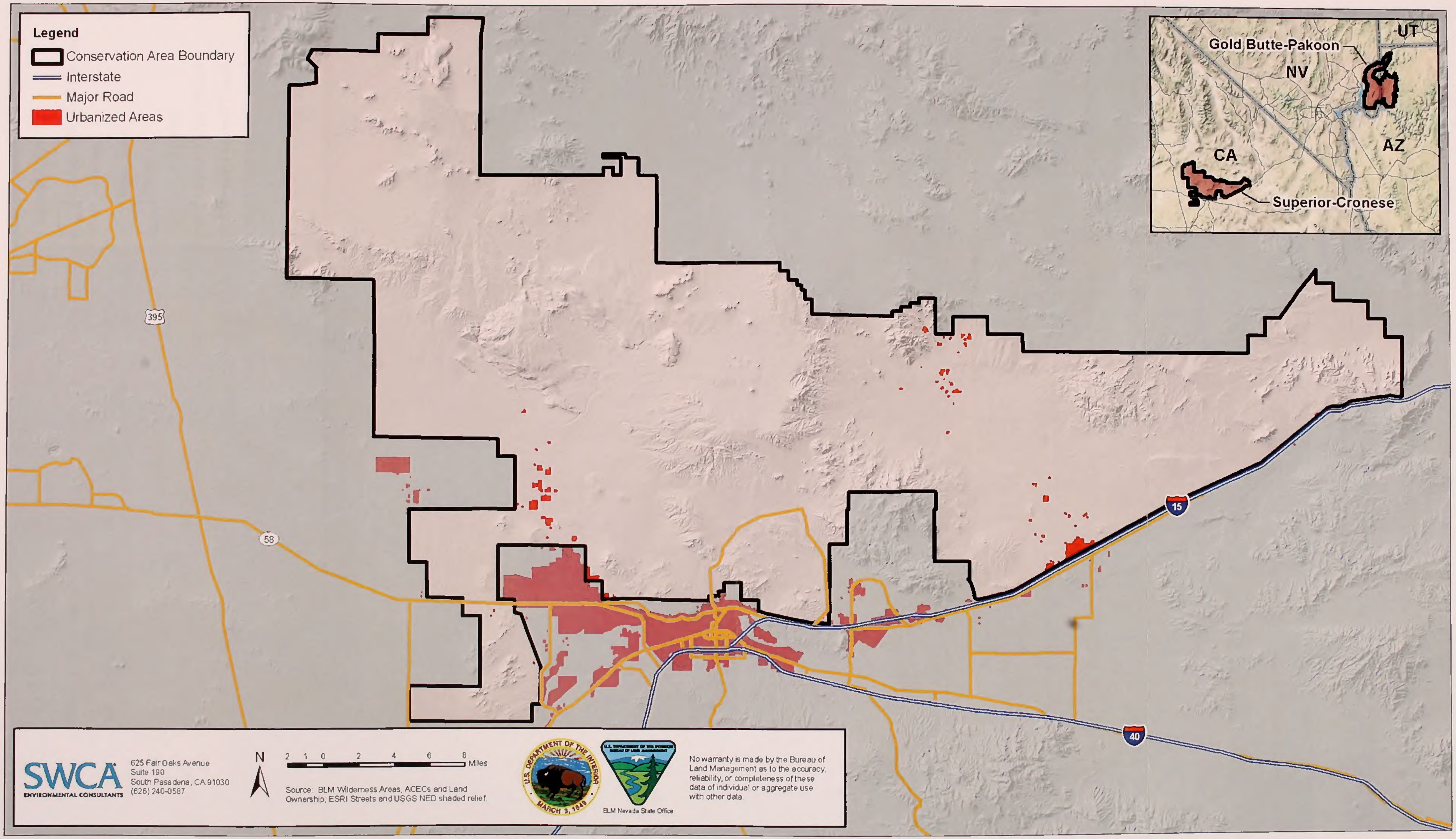

Figure D-2. Urbanized Areas Located within and Adjacent to the Superior-Cronese Conservation Area

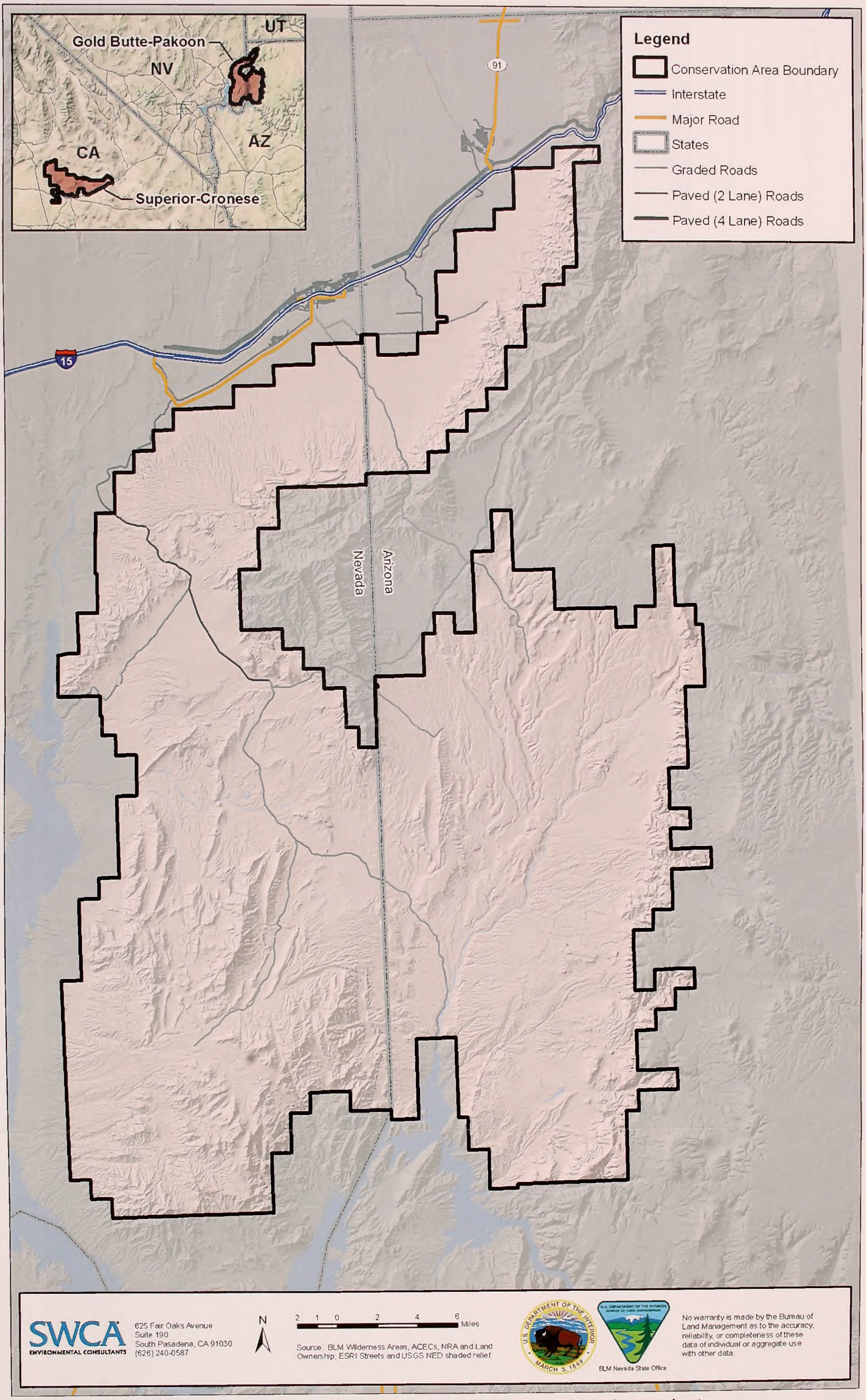

Figure D-3. Roads Located within and Adjacent to the Gold Butte-Pakoon Conservation Area

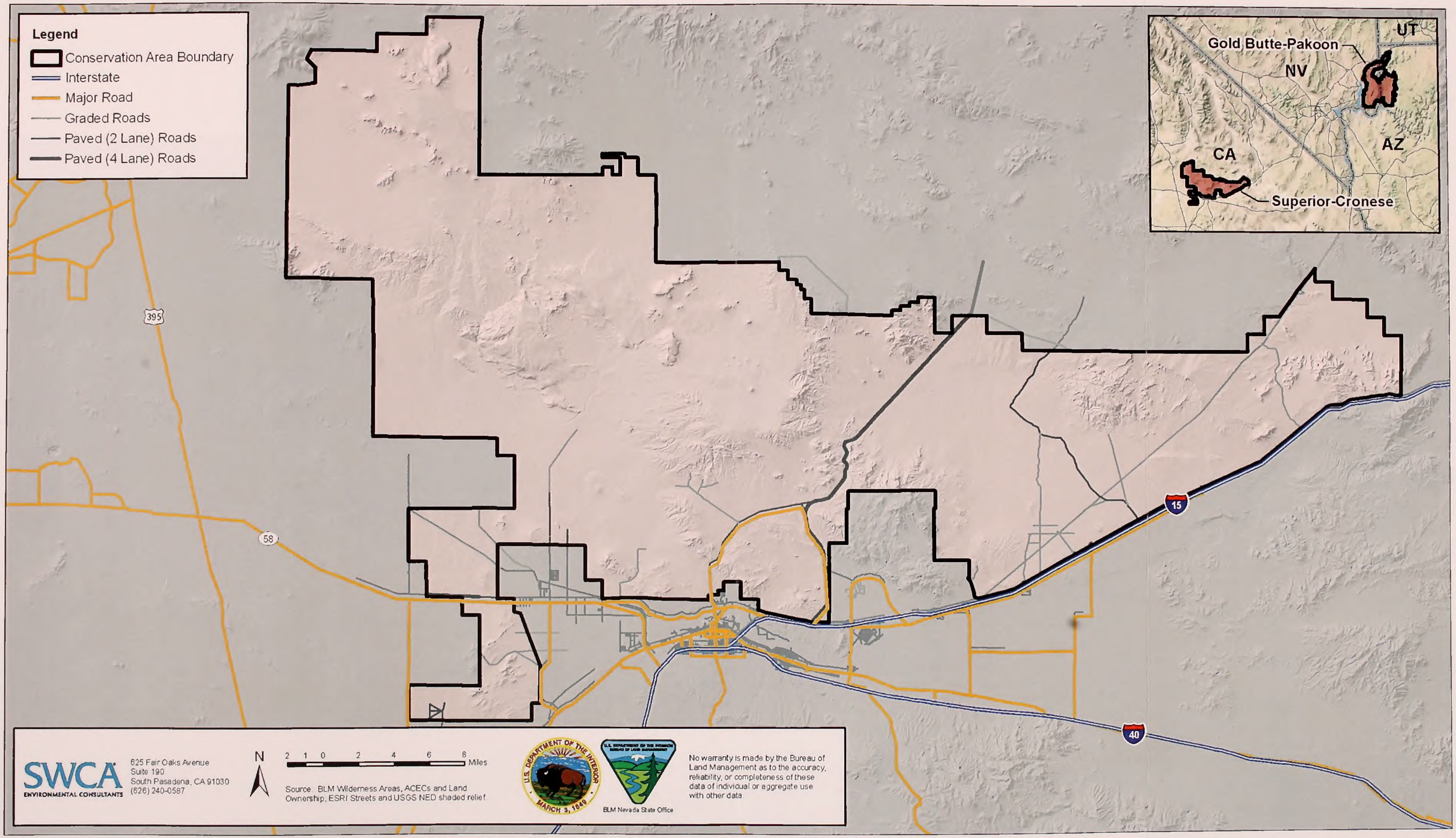

Figure D-4. Roads Located within and Adjacent to the Superior-Cronese Conservation Area

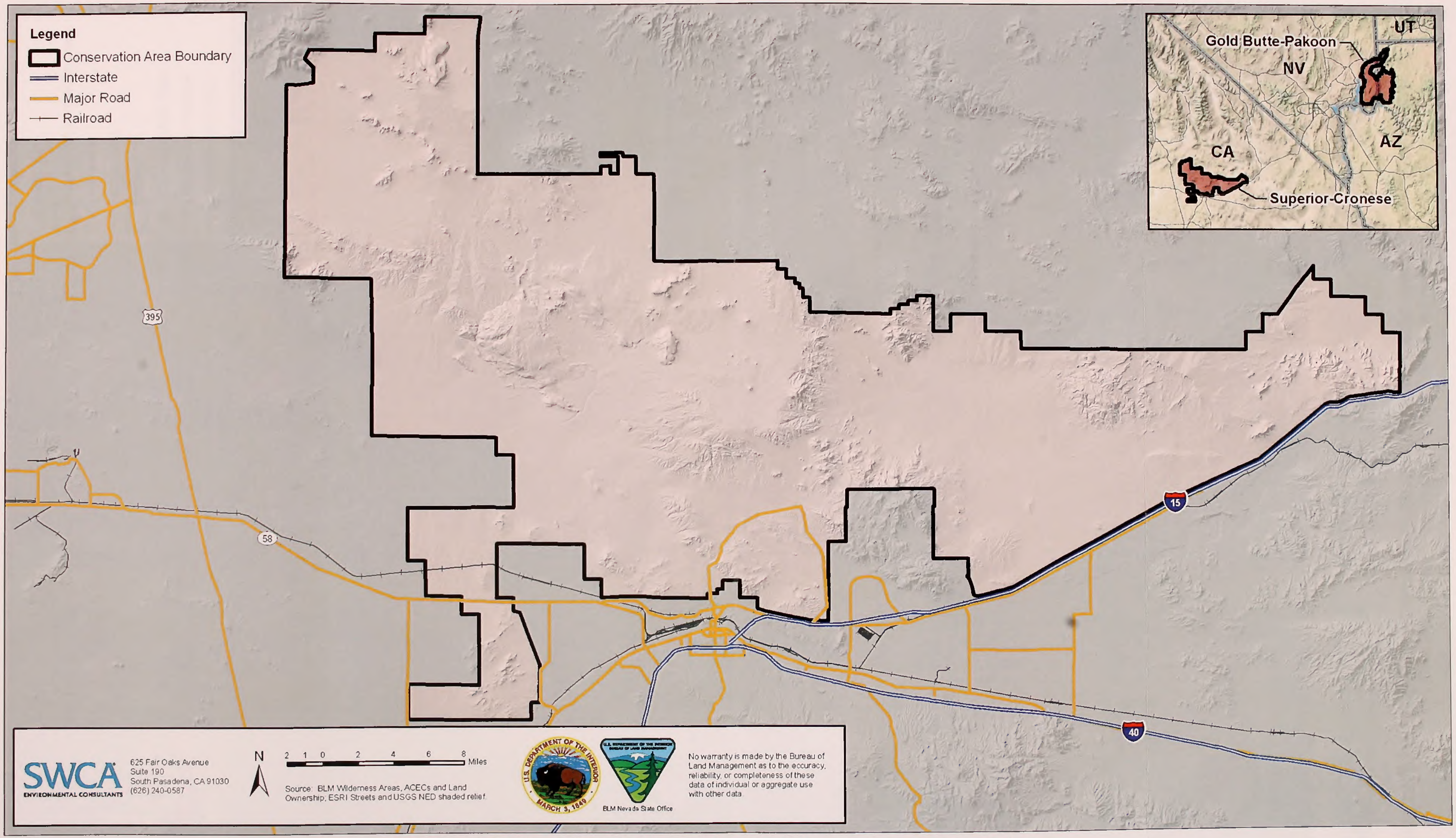

Figure D-5. Railroads Located within and Adjacent to the Superior-Cronese Conservation Area

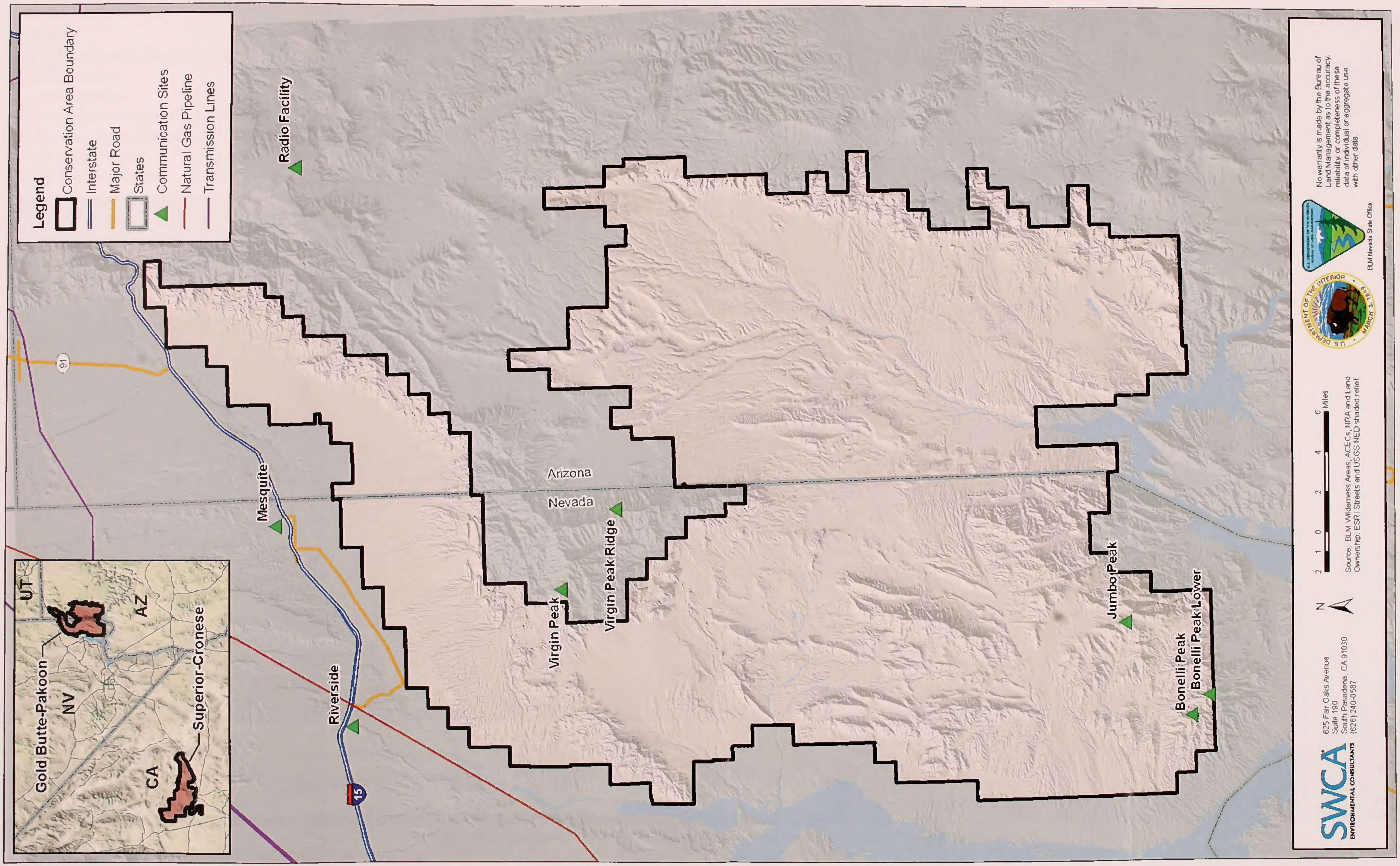

Figure D-6. Utilities Located within and Adjacent to the Gold Butte-Pakoon Conservation Area

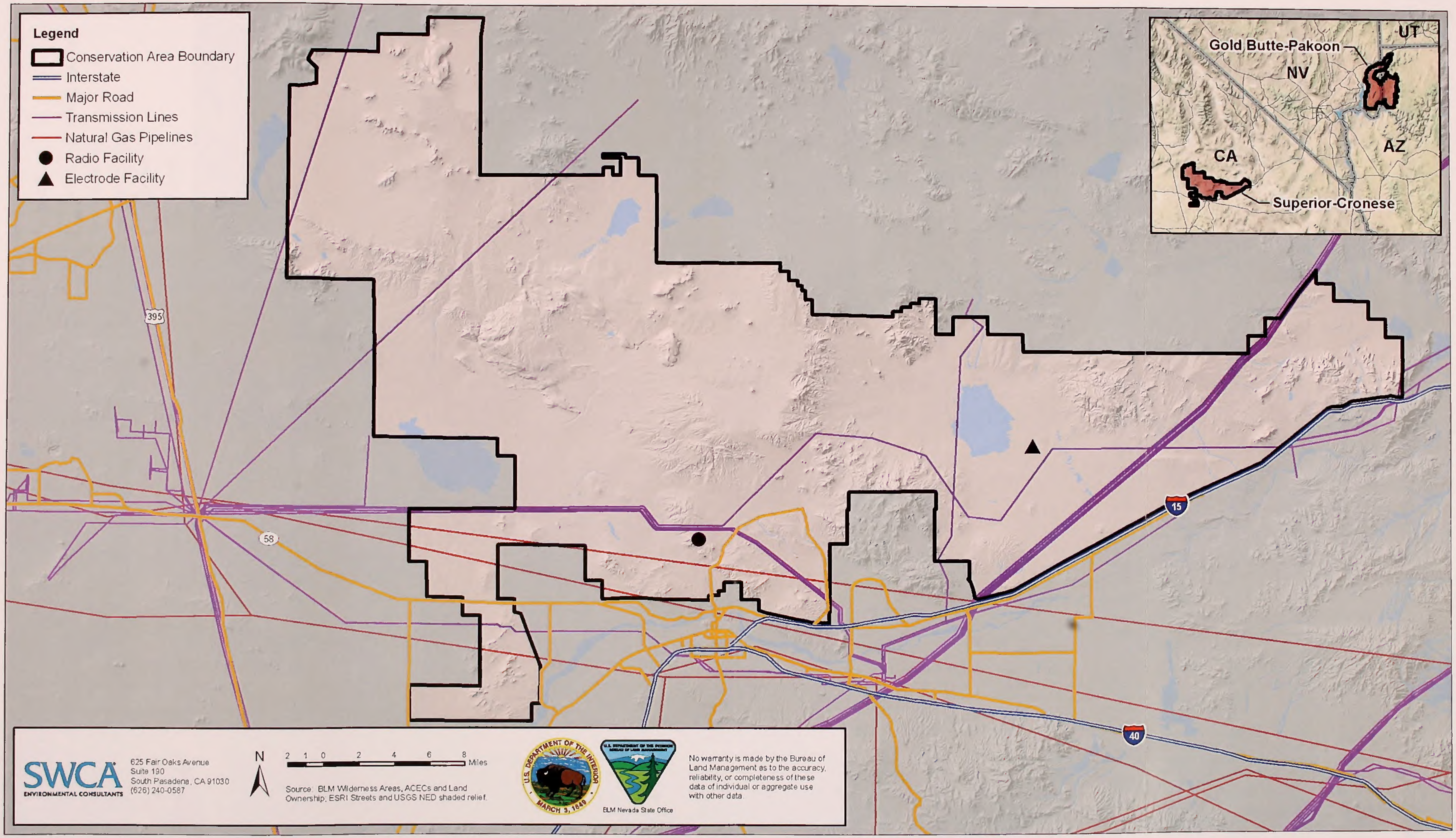

Figure D-7. Utilities Located within and Adjacent to the Superior-Cronese Conservation Area

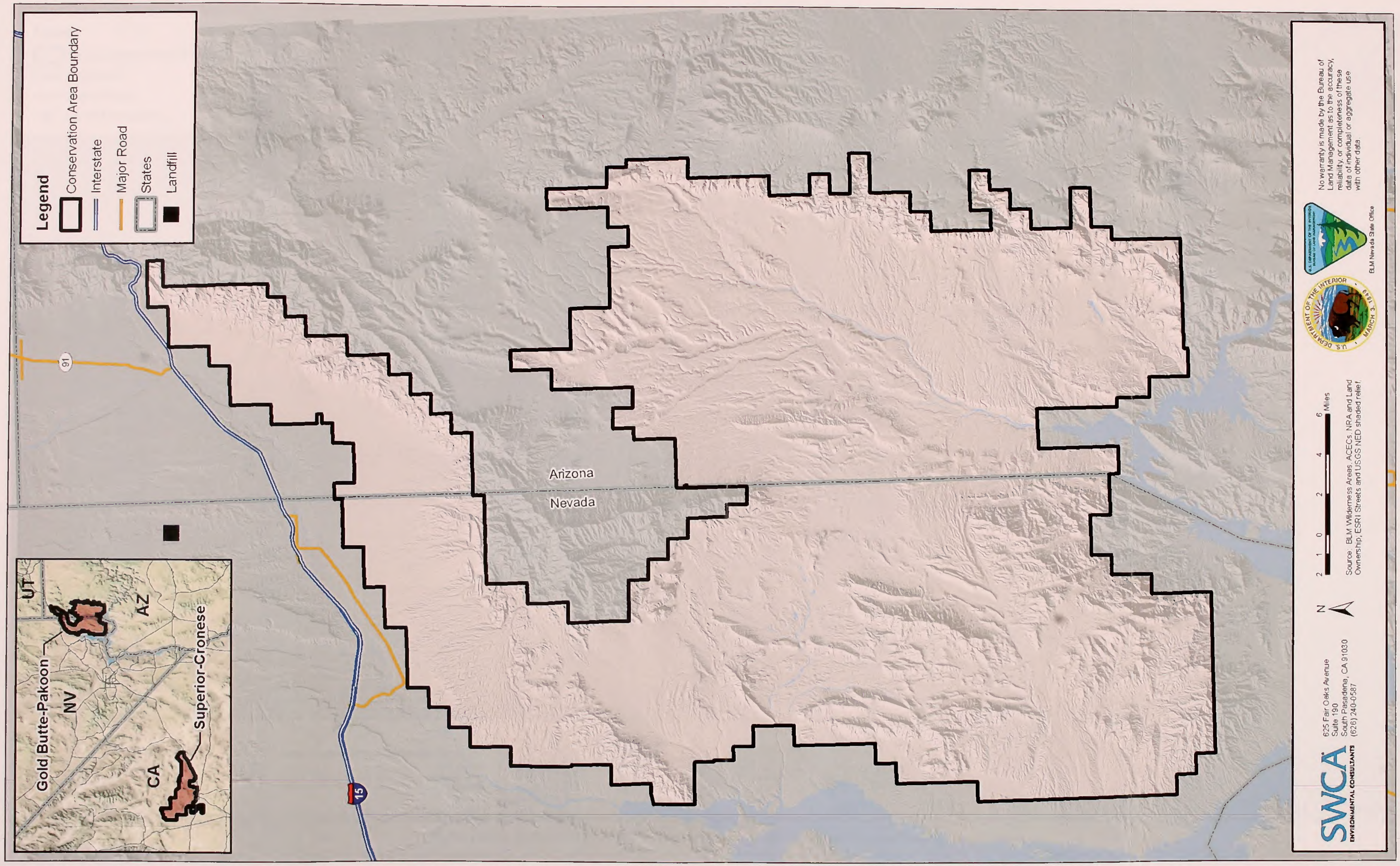

Figure D-8. Landfill Located Adjacent to the Gold Butte-Pakoon Conservation Area

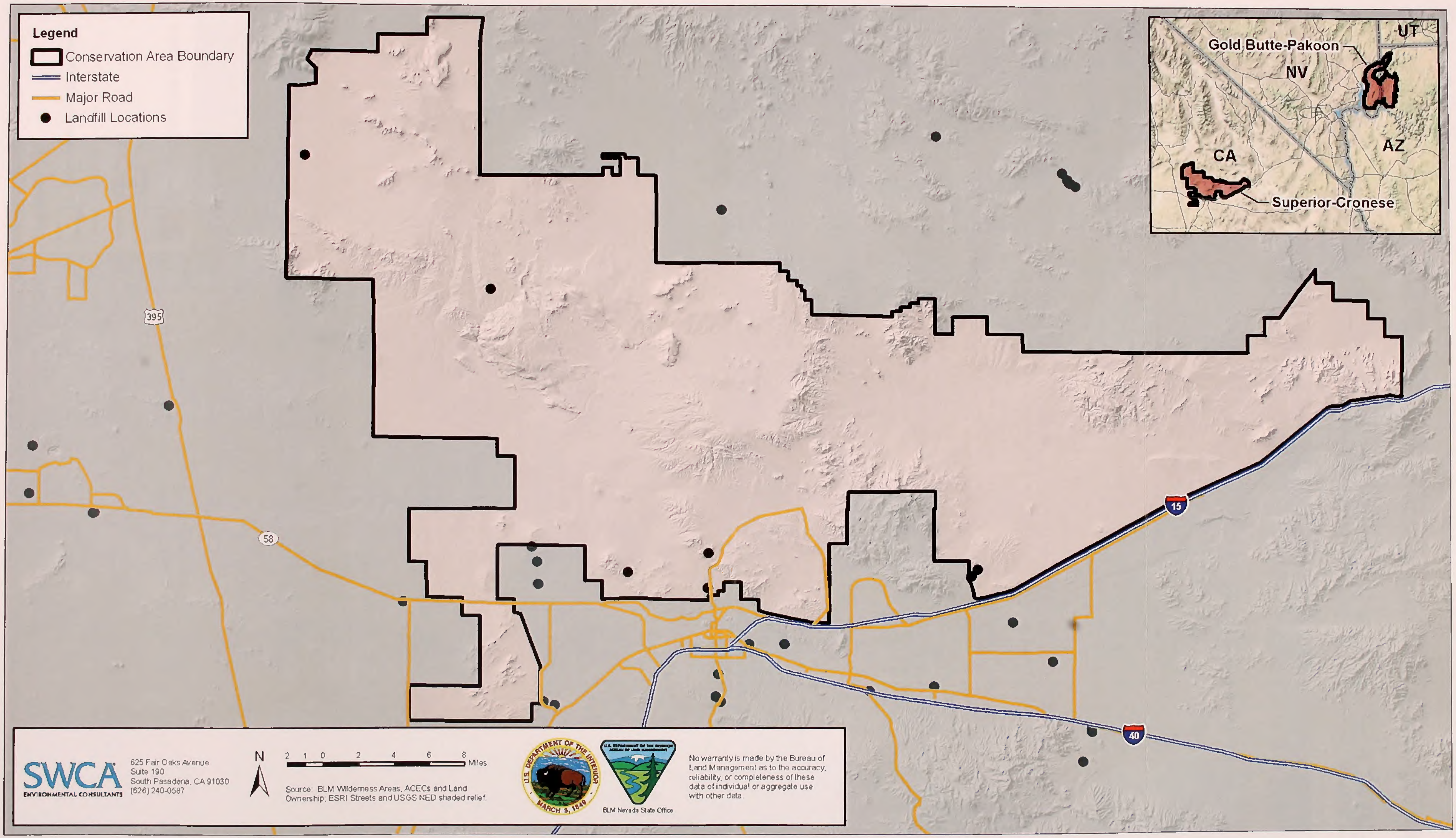

Figure D-9. Landfills Located within and Adjacent to the Superior-Cronese Conservation Area

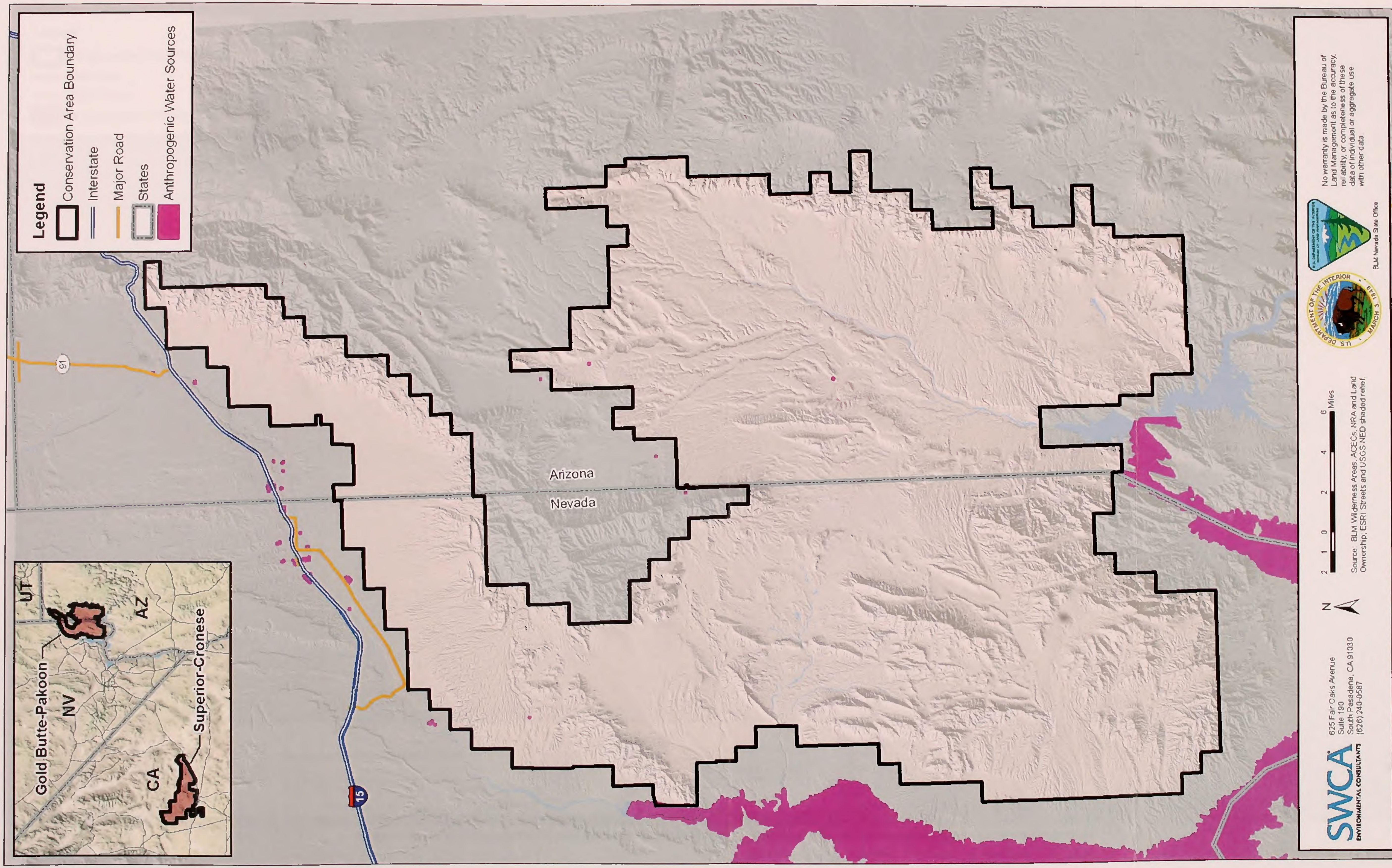

Figure D-10. Anthropogenic Water Sources Located within and Adjacent to the Gold Butte-Pakoon Conservation Area

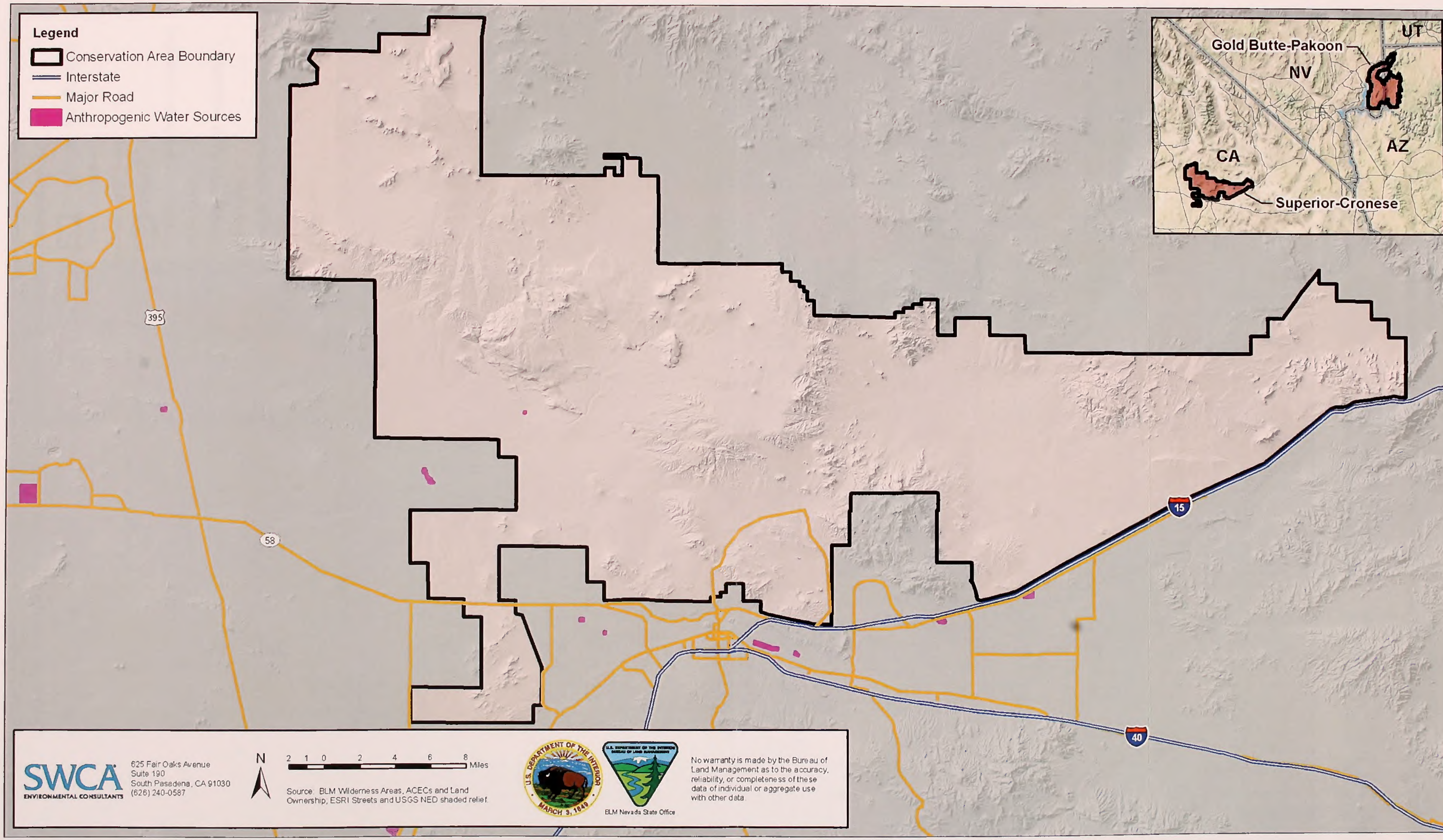

Figure D-11. Anthropogenic Water Sources Located within and Adjacent to the Superior-Cronese Conservation Area

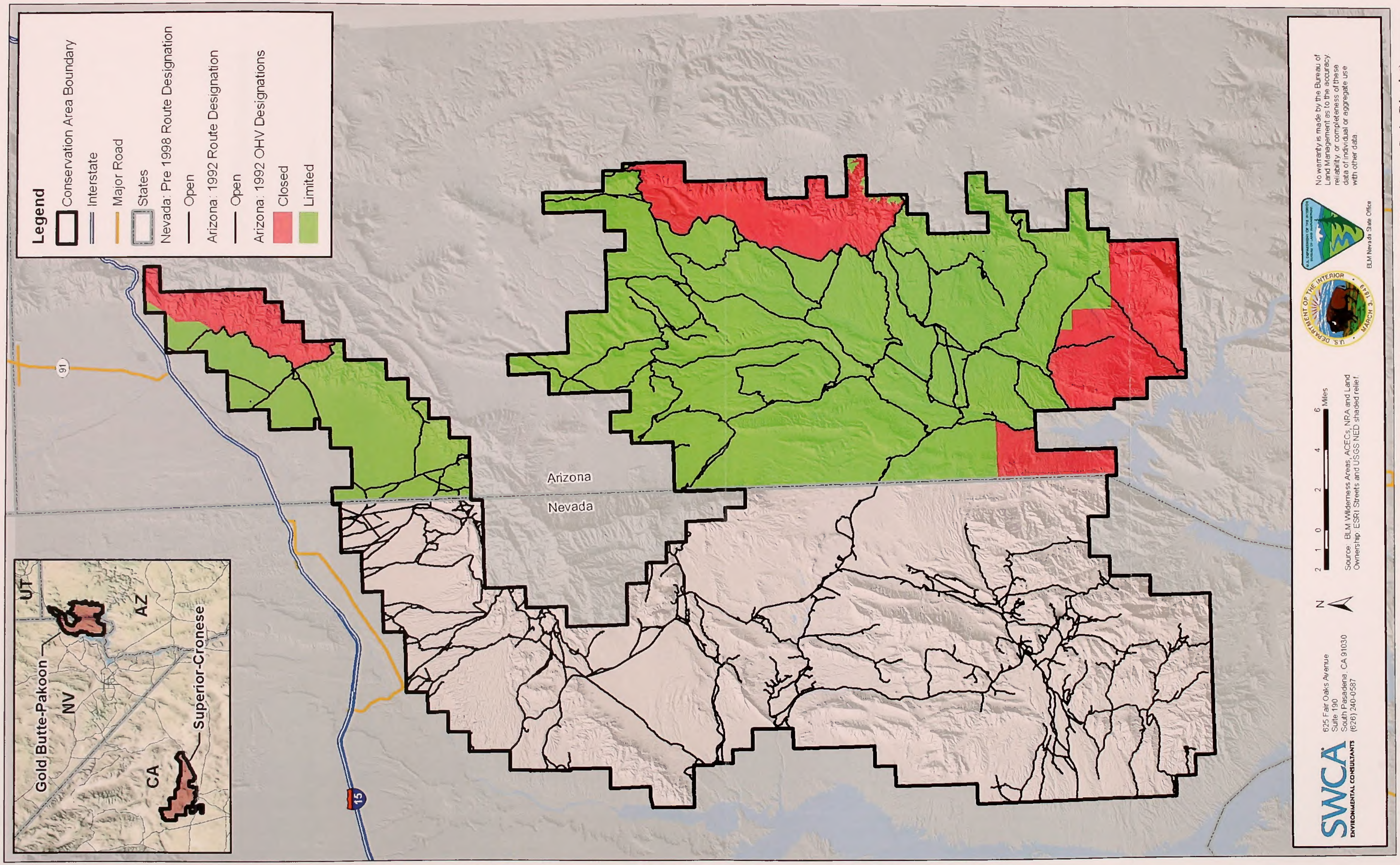

Figure D-12. BLM OHV Route Designations in the Gold Butte-Pakoon Conservation Area, 1992 (Arizona Strip District) and Pre-1998 (Las Vegas District)

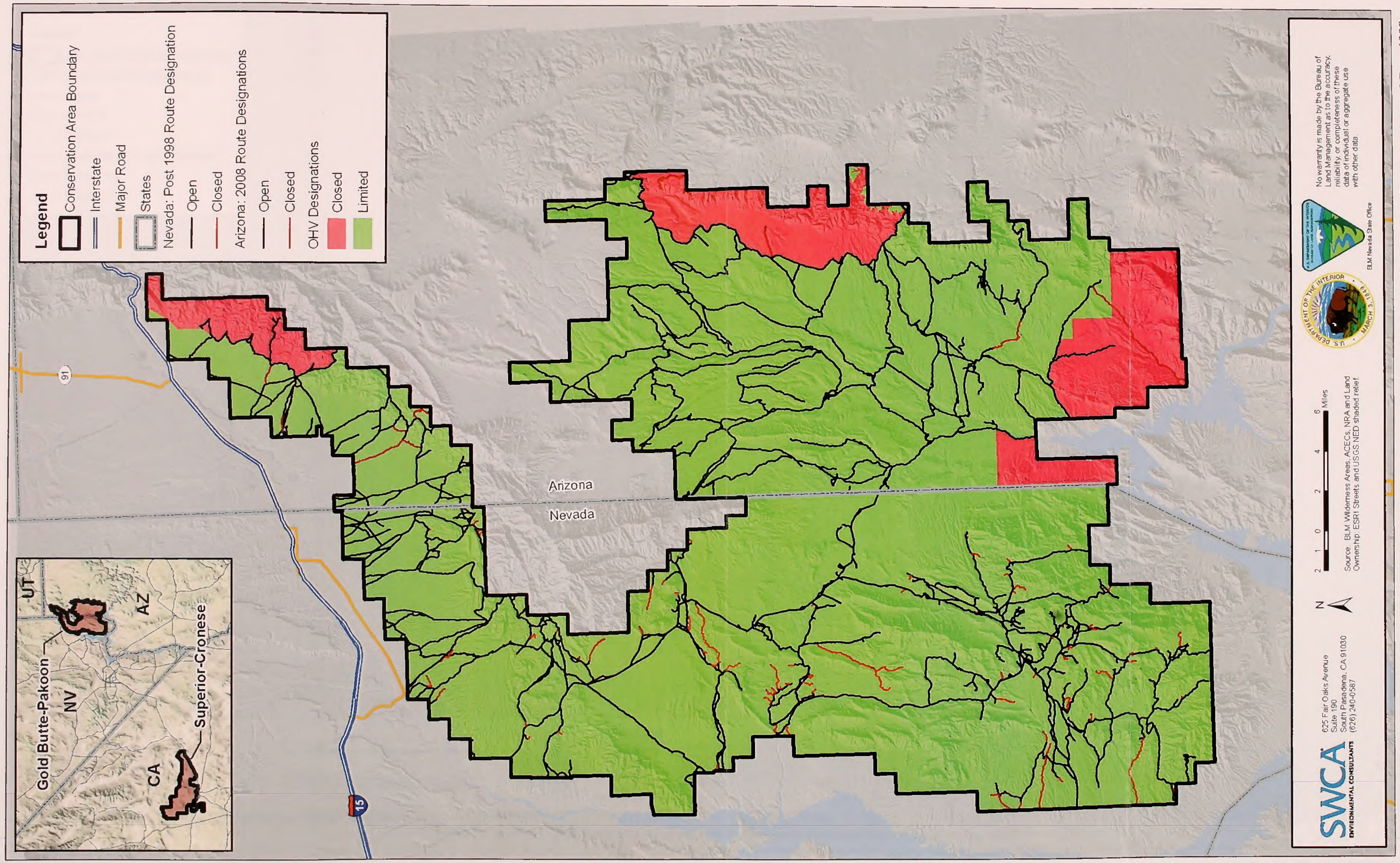

Figure D-13. BLM OHV Route Designations in the Gold Butte-Pakoon Conservation Area, 2008 (Arizona Strip District) and Post-1998 (Las Vegas District)

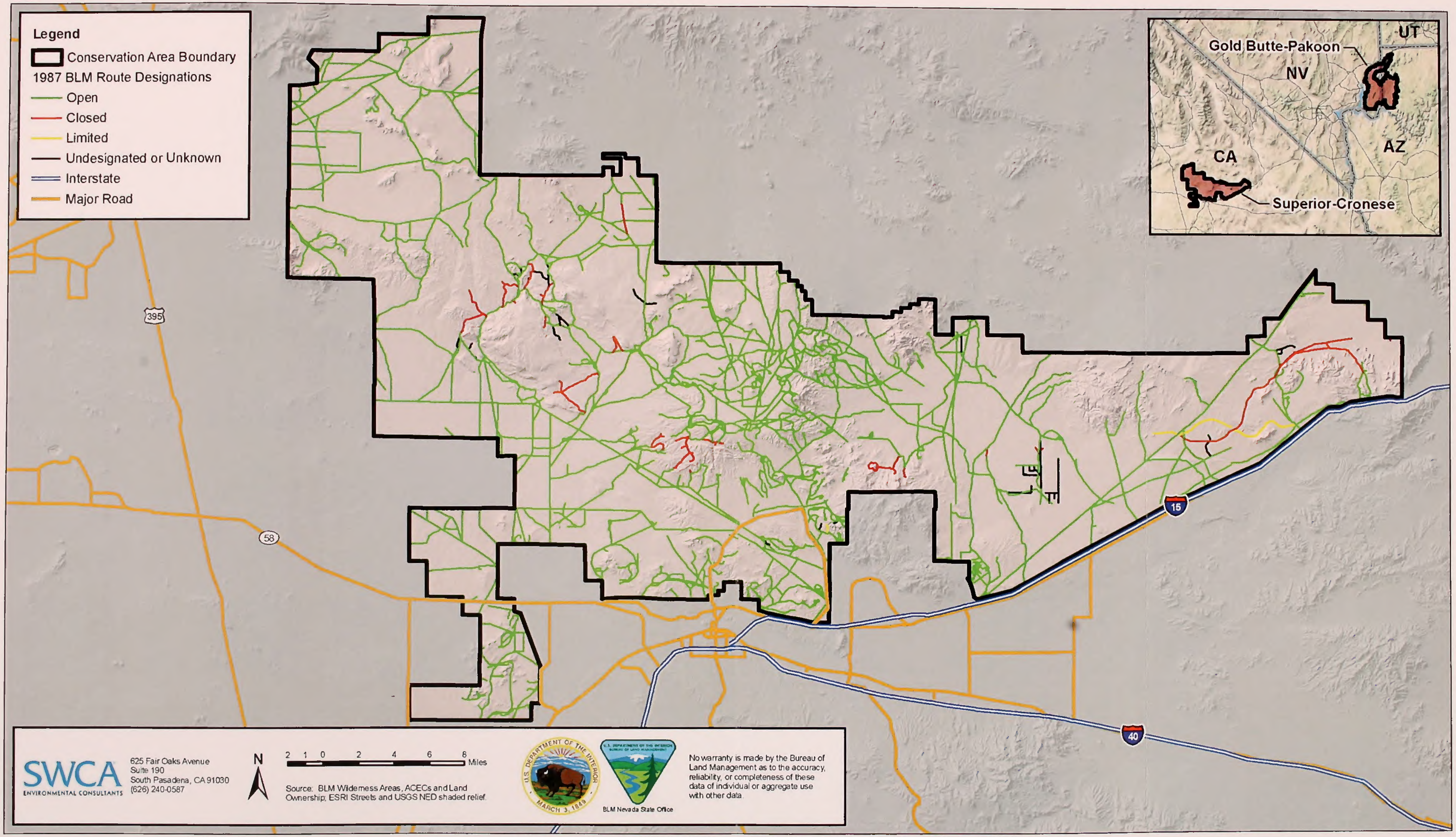

Figure D-14. BLM OHV Route Designations in the Superior-Cronese Conservation Area, 1987

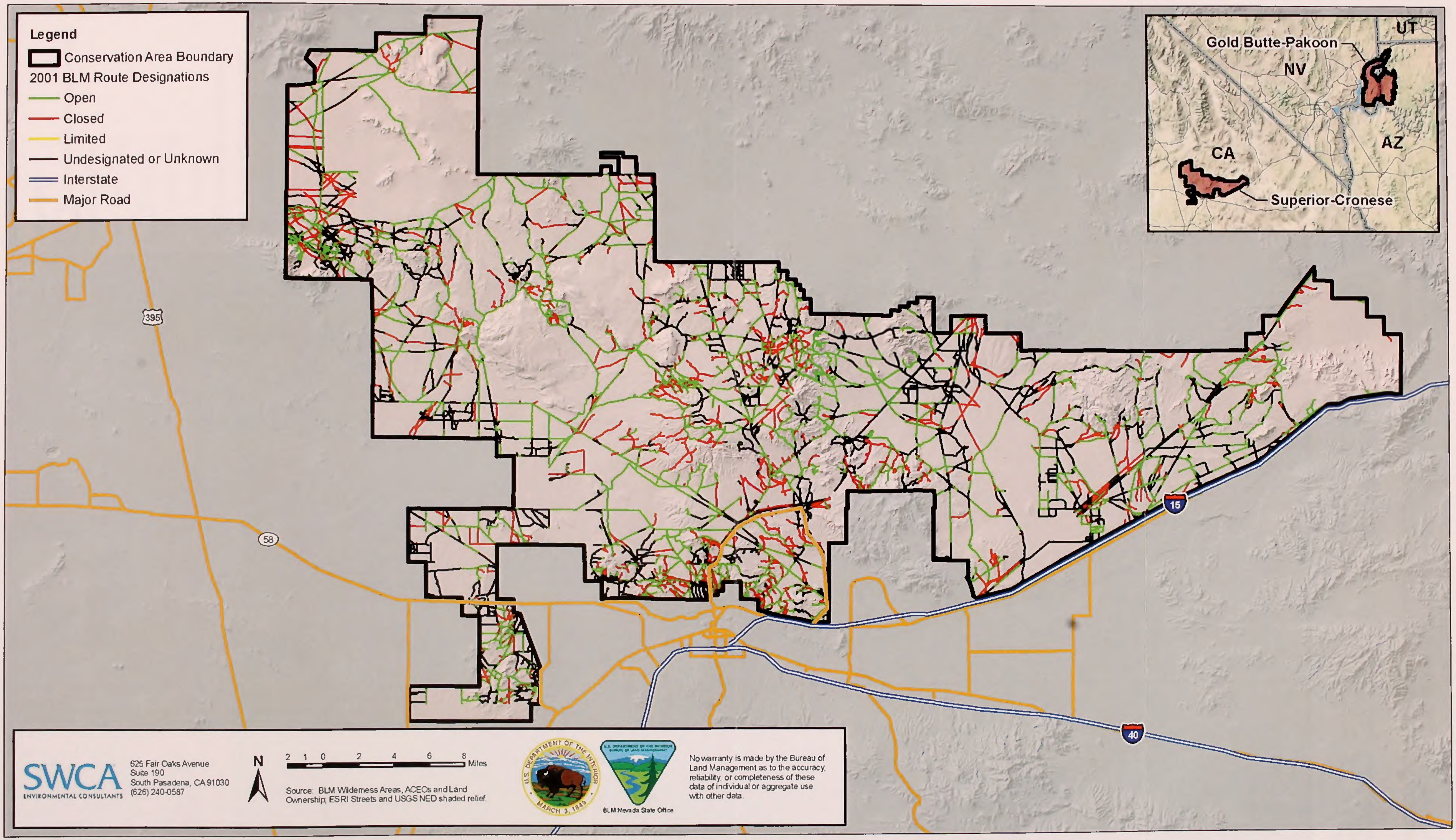

Figure D-15. BLM OHV Route Designations in the Superior-Cronese Conservation Area, 2001

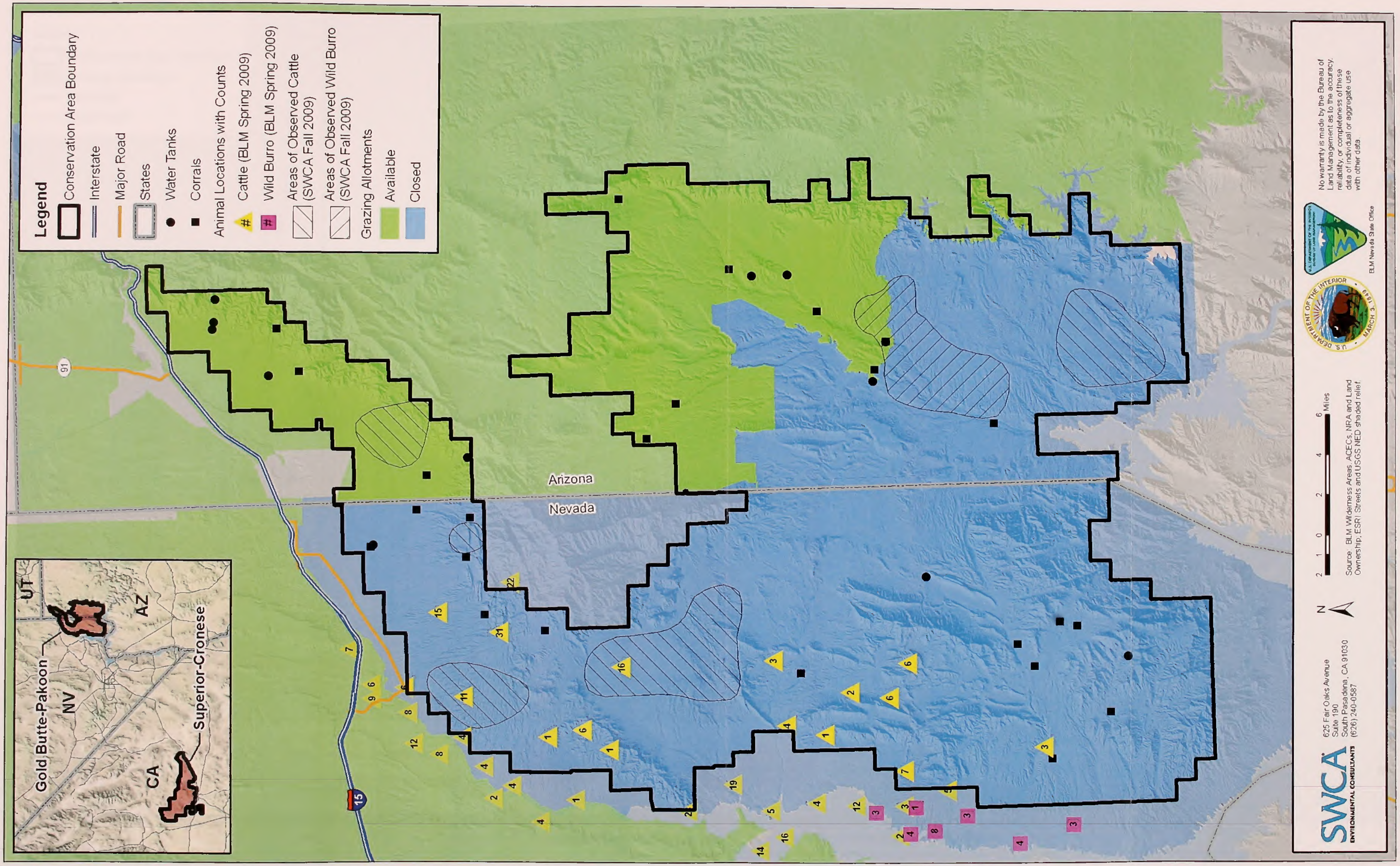

Figure D-16. Grazing Allotments, Closures, Trespass, and Infrastructure in the Gold Butte-Pakoon Conservation Area, Post-2004

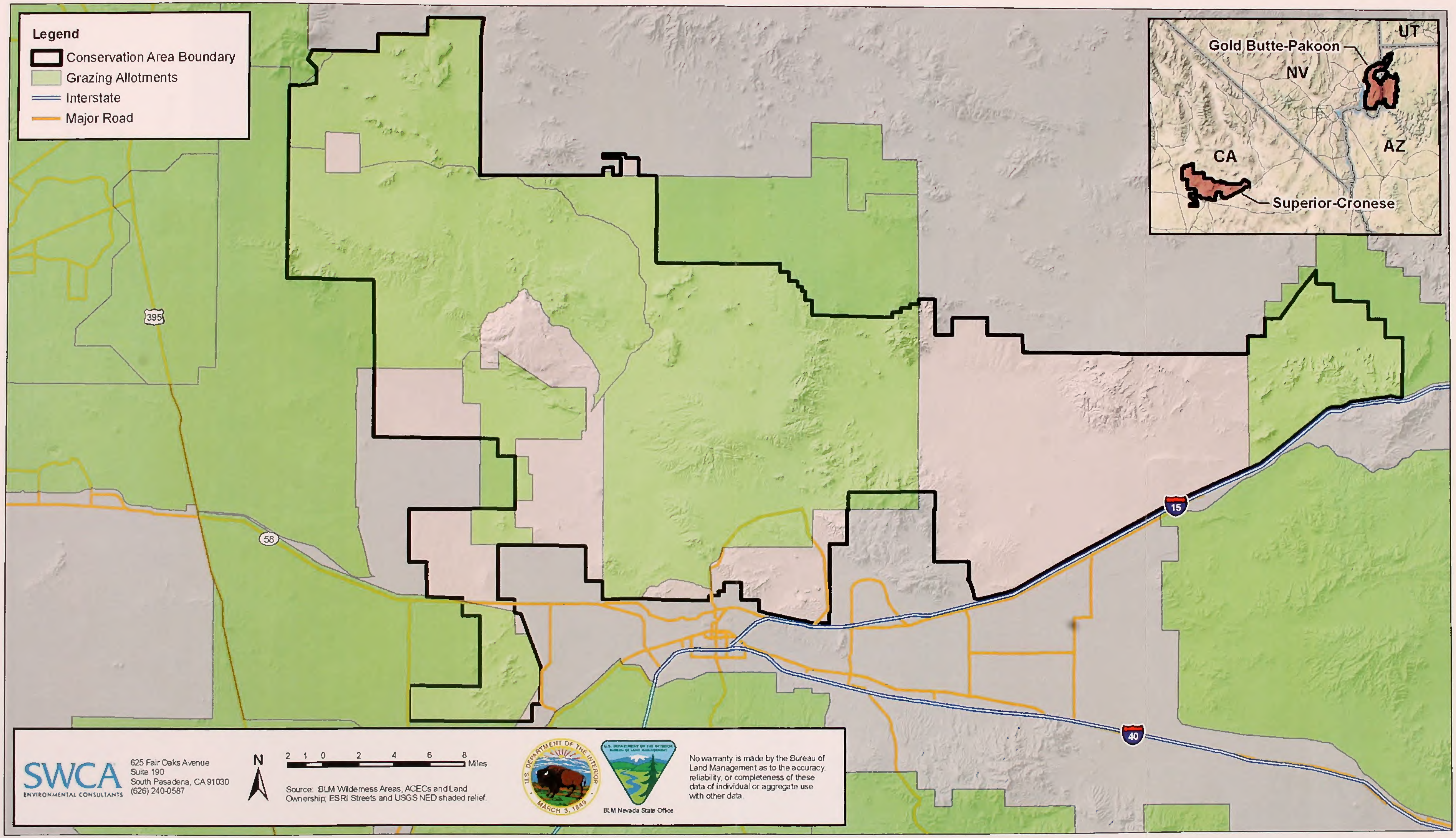

Figure D-17. Grazing Allotments in the Superior-Cronese Conservation Area, Pre-2006

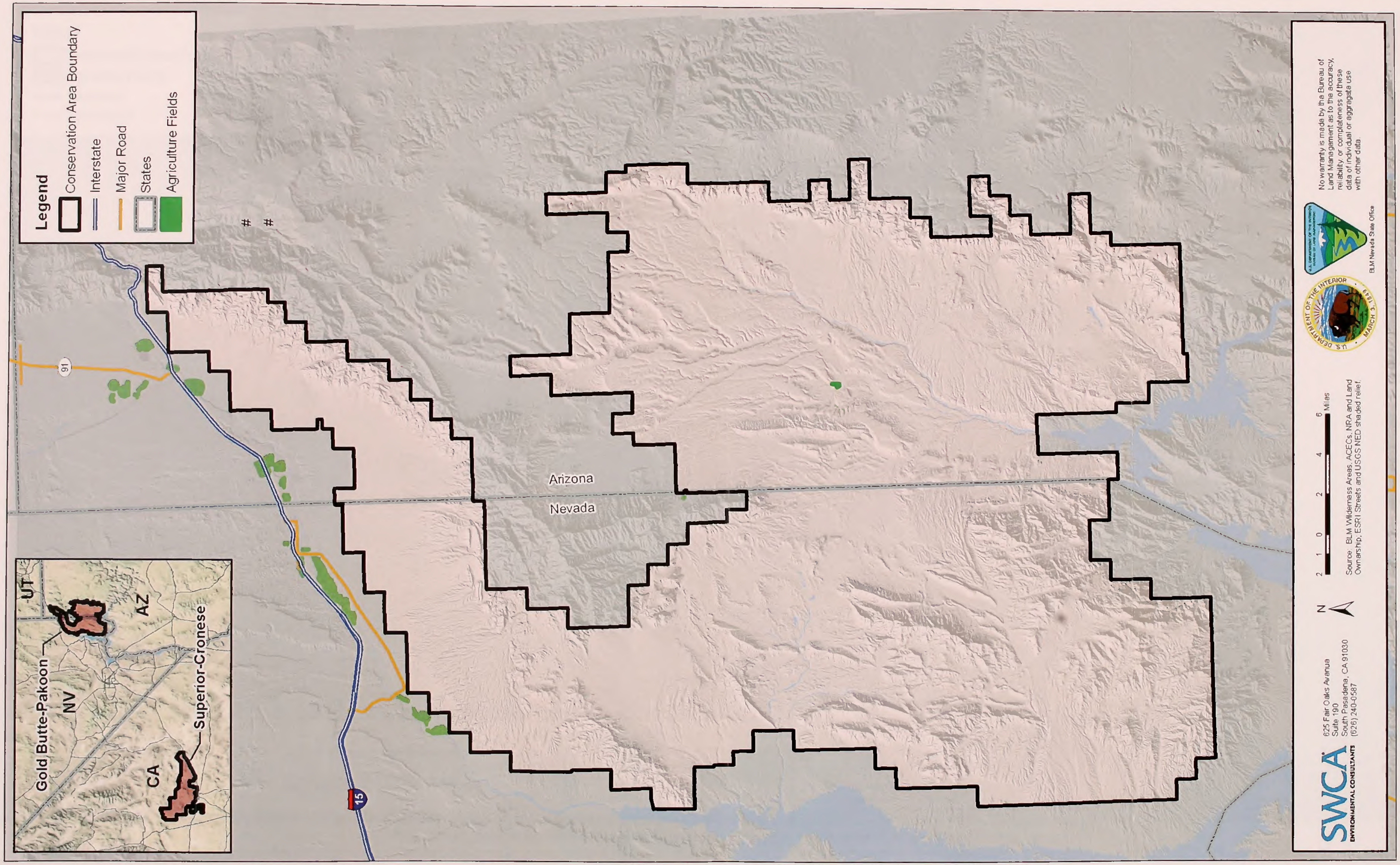

Figure D-18. Agricultural Fields Located Adjacent to the Gold Butte-Pakoon Conservation Area

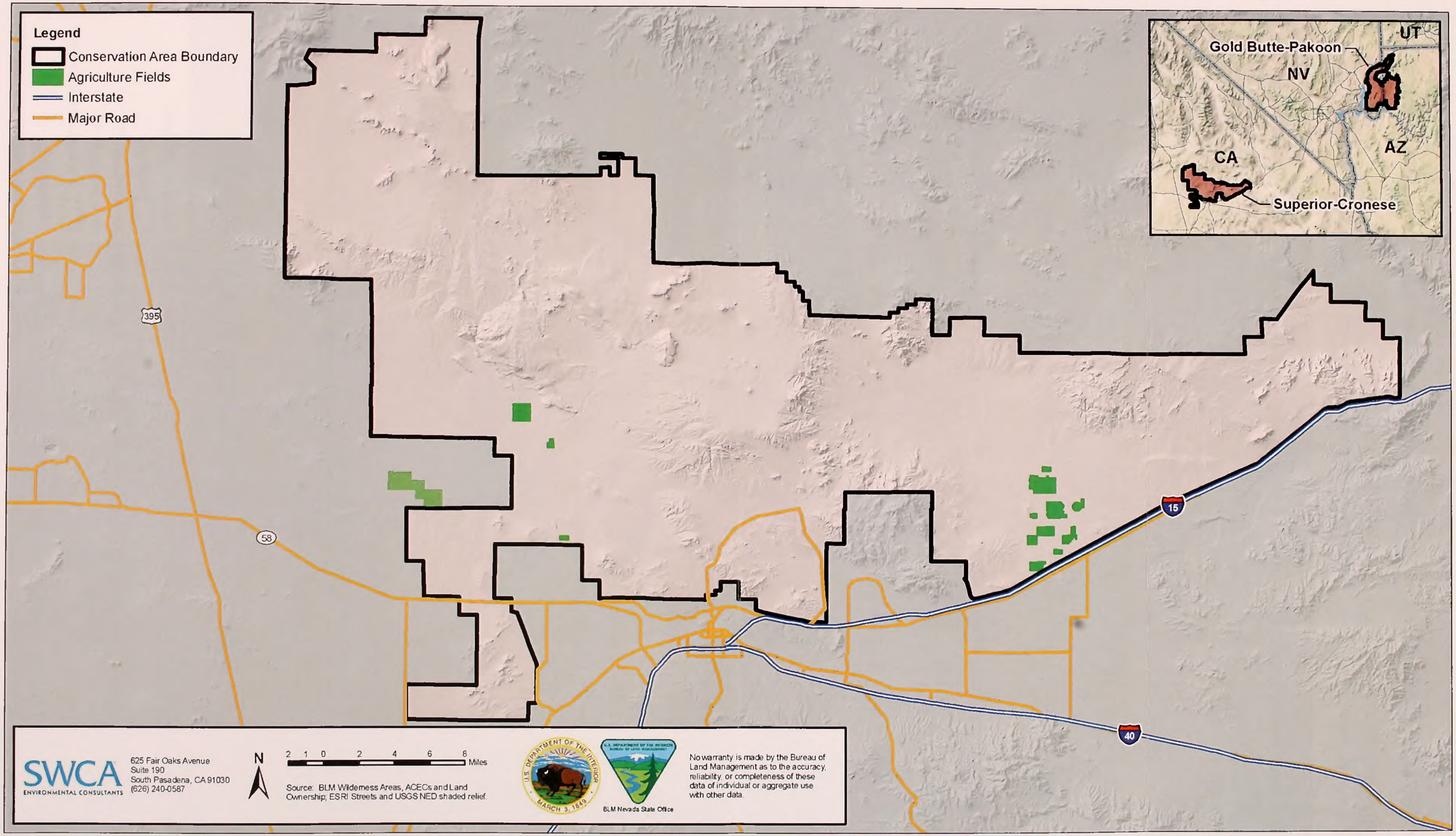

Figure D-19. Agricultural Fields Located within and Adjacent to the Superior-Cronese Conservation Area

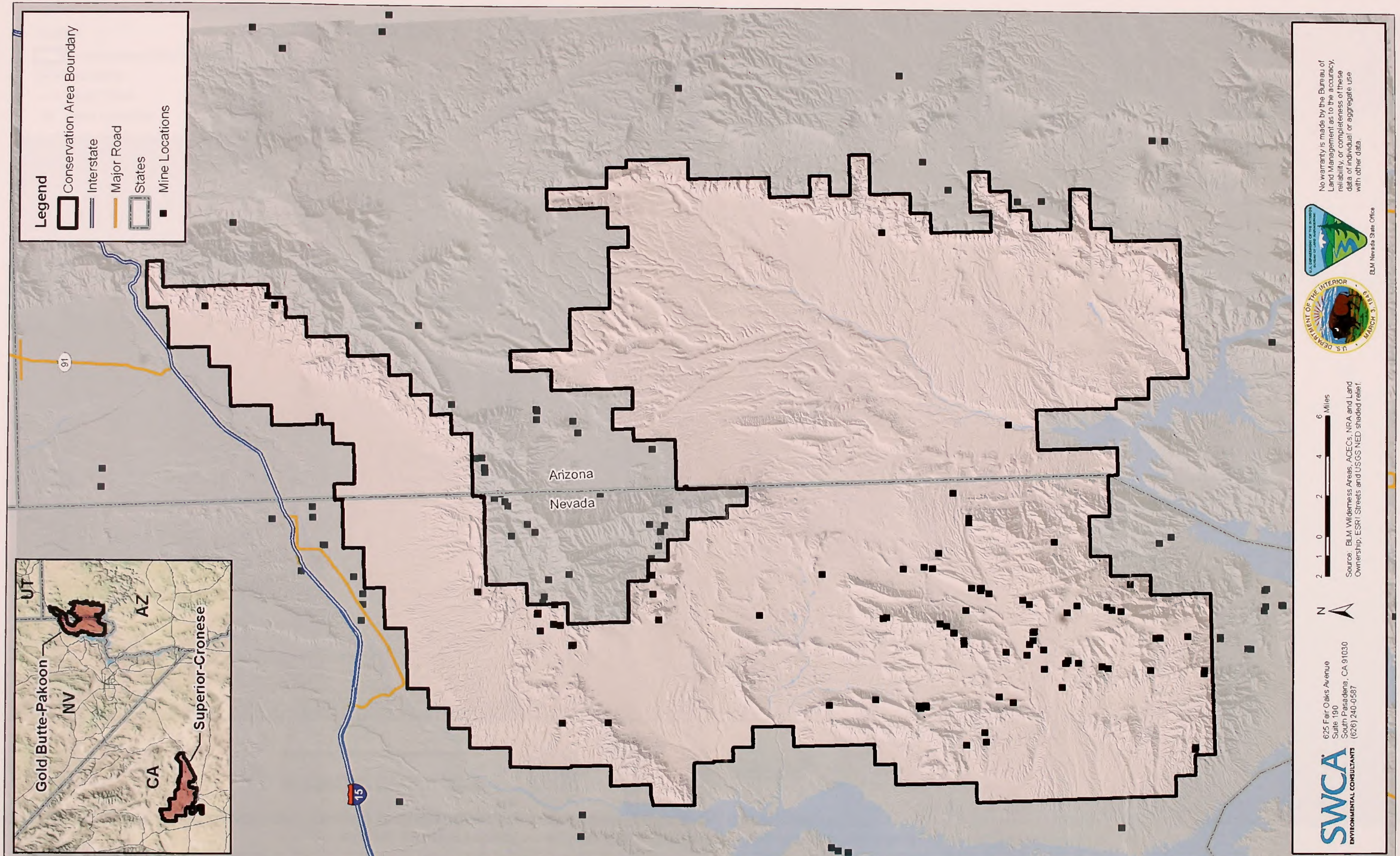

Figure D-20. Mines and Mineral Extraction Sites Located within and Adjacent to the Gold Butte-Pakoon Conservation Area

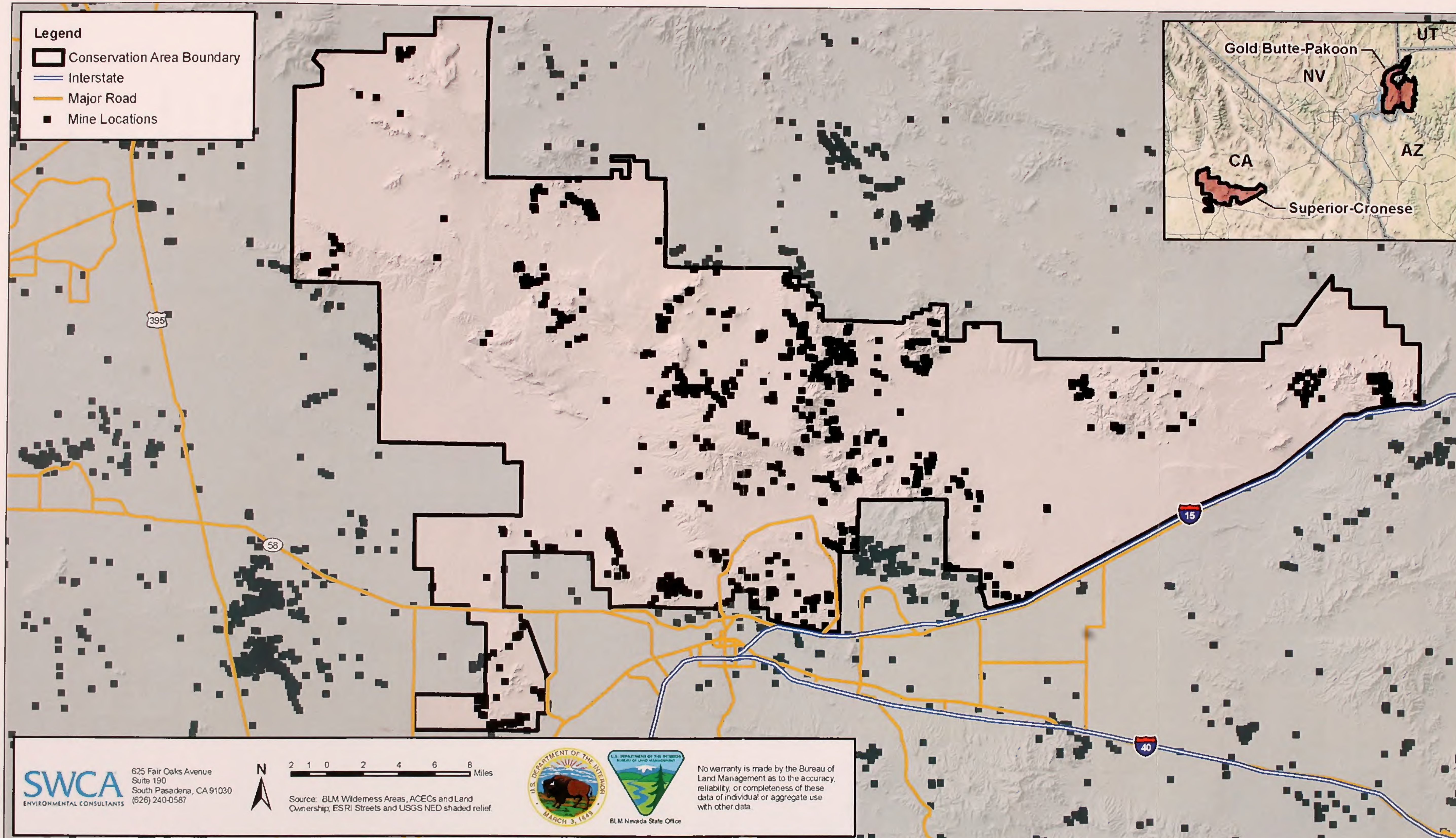

Figure D-21. Mines and Mineral Extraction Sites Located within and Adjacent to the Superior-Cronese Conservation Area

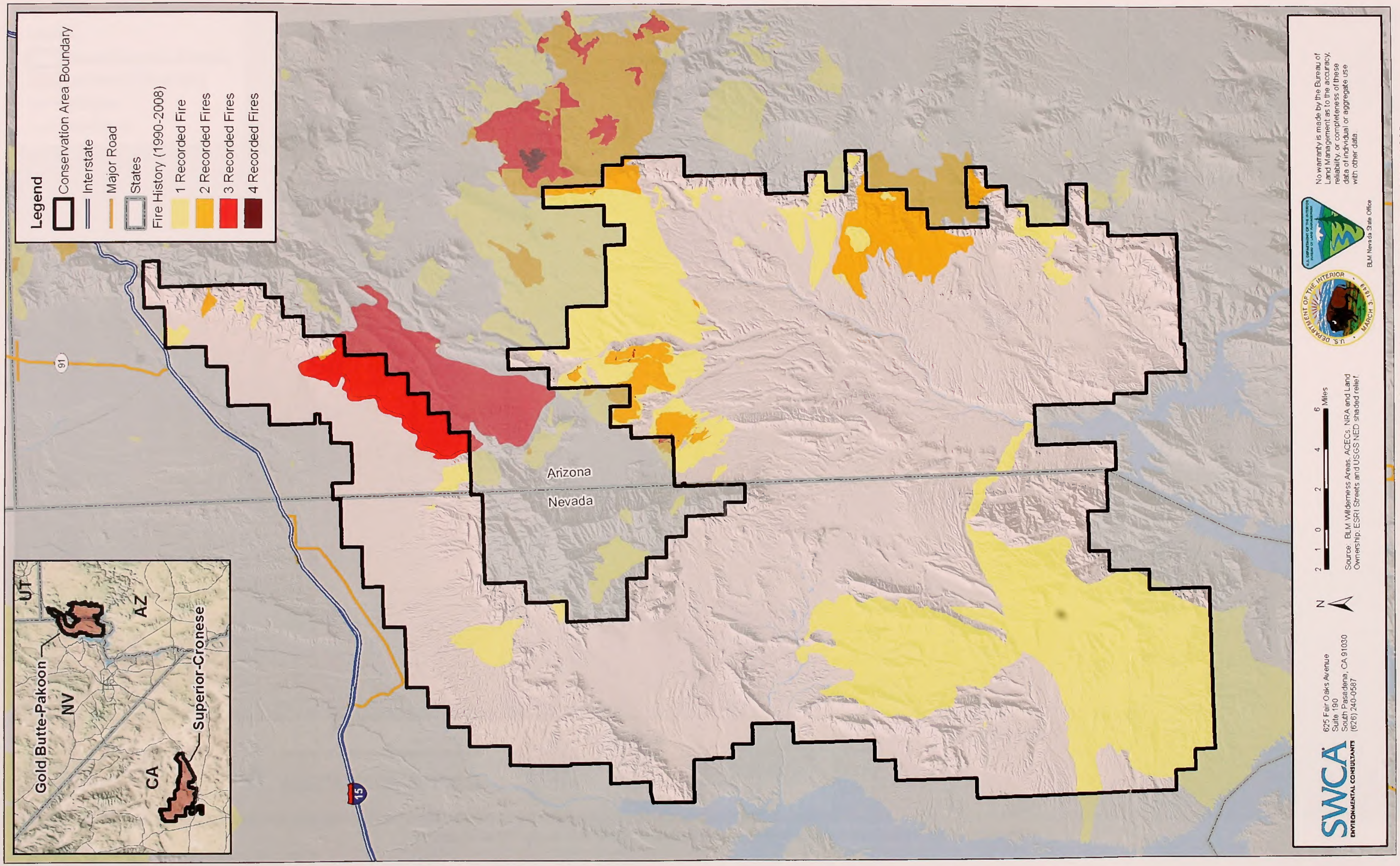

Figure D-22. Fire History in and Adjacent to the Gold Butte-Pakoon Conservation Area, 1990-2008

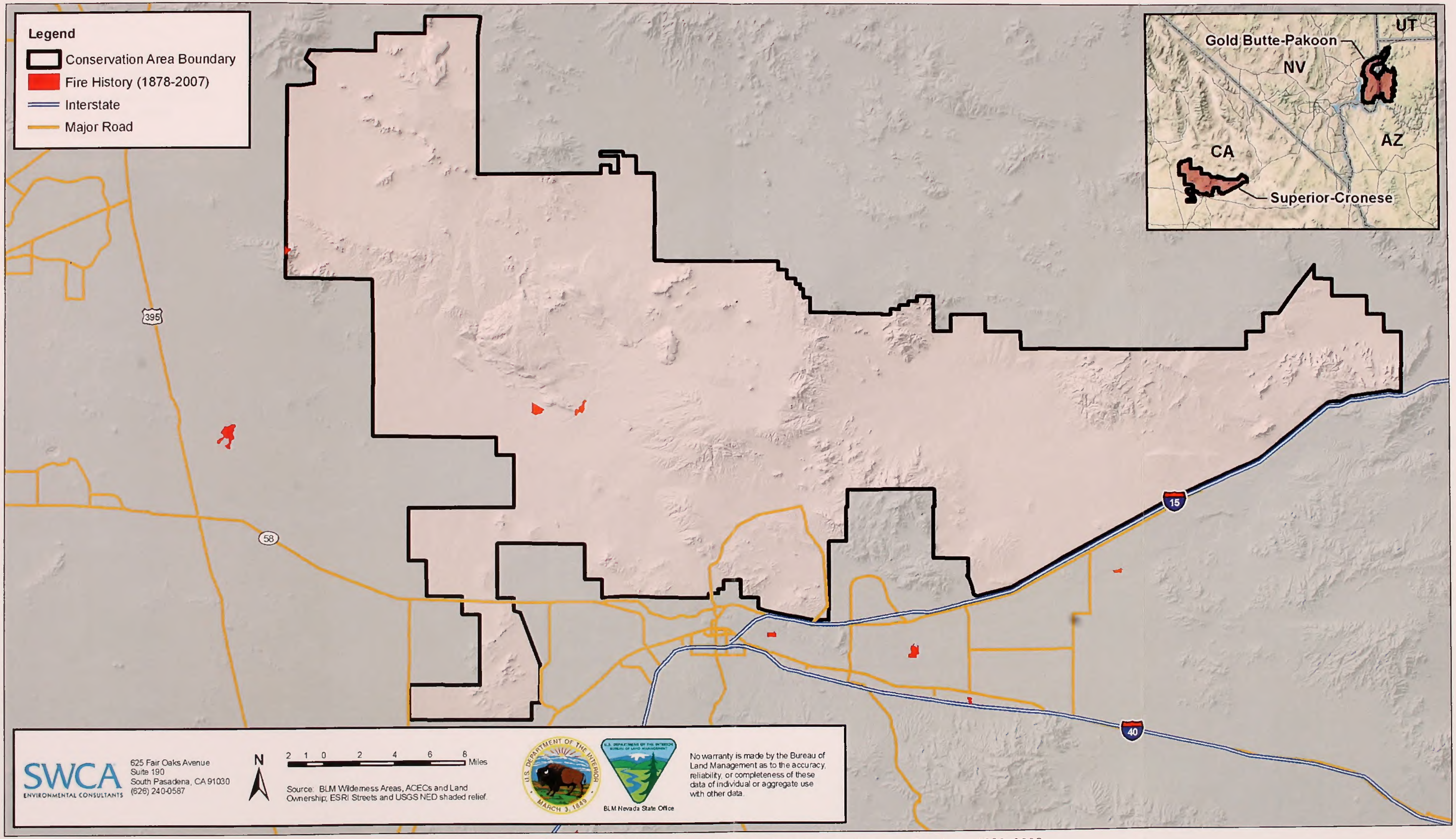

Figure D-23. Fire History in and Adjacent to the Superior-Cronese Conservation Area, 1990–2008

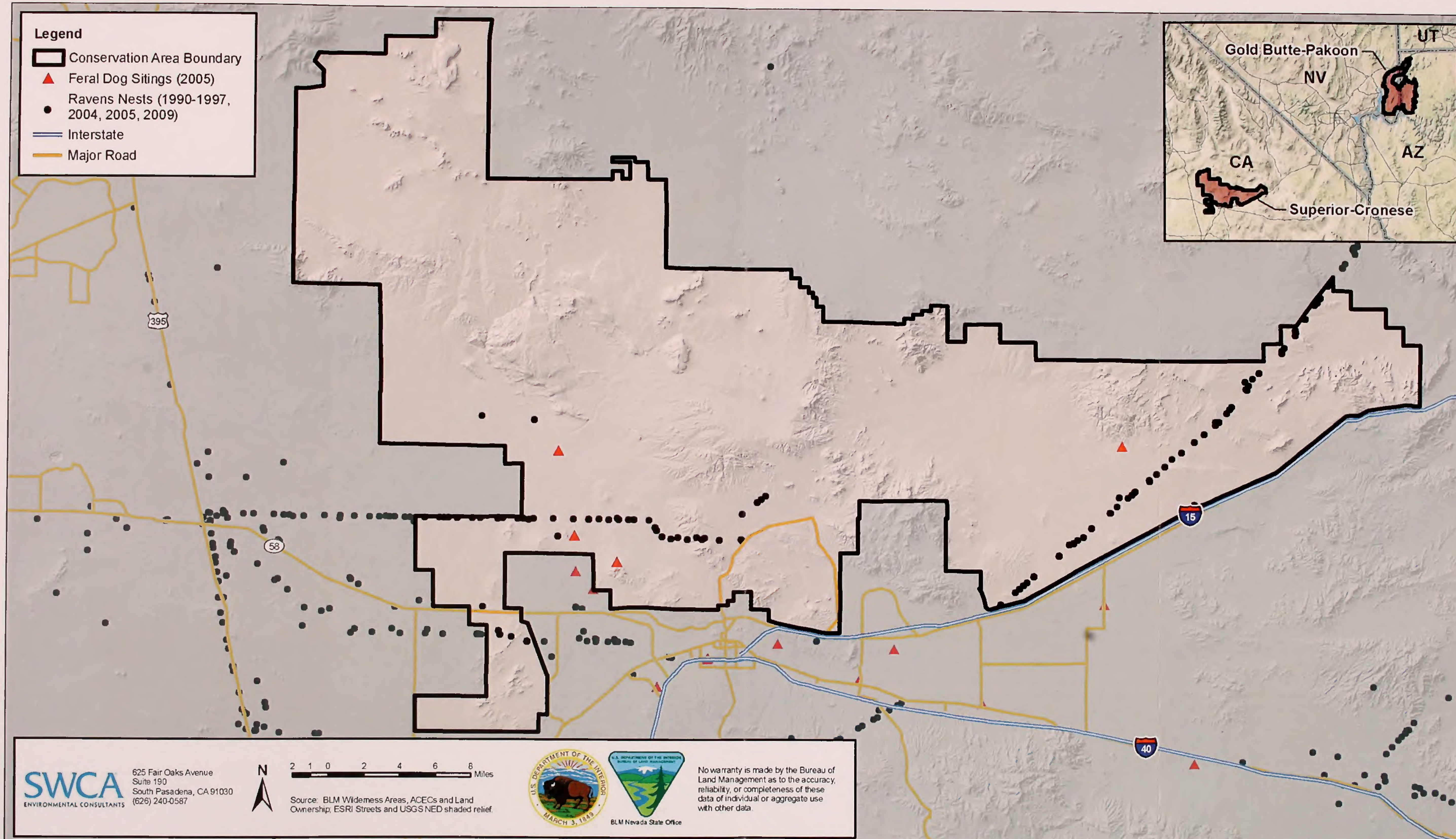

Figure D-24. Raven Nests and Feral Dog Observations in the Superior-Cronese Conservation Area, 1990–2009

Appendix E: Rationale for Threats Scoring

1. THREAT SCORES (M_t, H_t, A_t, and I_t)

1.1 Human Developments

1.1.1 Urbanization

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Urbanization has the potential to contribute substantially to tortoise mortality, particularly as new areas are developed.

Mortality variable (M_t) = 3

Urbanization contributes significantly to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

Urbanization provides considerable opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 3

Cumulative and Interactive Effects

Urbanization interacts with 14 other threats, including being associated with roads, utilities, and landfills; providing anthropogenic water sources; facilitating OHV use, collecting and poaching by humans, litter and illegal dumping, and the introduction of toxins and pollutants into desert environments; and contributing to poor air quality, climate change, spread of invasive plants and fire; providing subsidies to predators of desert tortoises; and increasing the incidence of disease within desert tortoise populations.

Interactive variable (I_t) = 3

1.1.2 Roads

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Roads contribute significantly to tortoise mortality through tortoise-vehicle strikes.

Mortality variable (M_t) = 3

Roads contribute significantly to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

Roads provide considerable opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 3

Cumulative and Interactive Effects

Roads interact with 16 other threats, including their association with urbanized areas, railroads, utilities, landfills, mines, and military facilities and activities; facilitating OHV use, collecting and poaching by humans, litter and illegal dumping, and the introduction of toxins and pollutants into desert environments; and contributing to poor air quality, climate change, spread of invasive plants, fires, and disease, and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 4

1.1.3 Railroads

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Though probably not as significant as roads, railroads have the potential to contribute substantially to tortoise mortality through train-tortoise strikes.

Mortality variable (M_t) = 2

Railroad corridors contribute significantly to the loss, degradation, and especially fragmentation of desert habitat.

Habitat variable (H_t) = 3

Railroads do not normally provide opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Railroads interact with five other threats, including acting cumulatively with roads and utility corridors to fragment habitat; introducing toxins and pollutants into desert environments; and contributing to poor air quality and the spread of invasive plants.

Interactive variable (I_t) = 1

1.1.4 Utilities

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Utilities contribute to tortoise mortality during construction and maintenance, and through tortoise-vehicle strikes along utility access roads.

Mortality variable (M_t) = 2

Utilities contribute to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

Access roads to and along utilities provide considerable opportunities for human access into desert areas.

Human Access variable (A_t) = 3

Cumulative and Interactive Effects

Utilities interact with nine other threats, including being associated with urbanized areas; acting cumulatively with roads and railroads to fragment habitat; facilitating OHV use, collection/poaching of tortoises, and illegal dumping along access roads; the introduction of toxins and pollutants into desert environments; and the spread of invasive plants; and providing subsidies (nesting structures for ravens) to predators of desert tortoises.

Interactive variable (I_t) = 2

1.1.5 Landfills

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Landfills contribute to tortoise mortality during construction and maintenance, and through tortoise-vehicle strikes along landfill access roads.

Mortality variable (M_t) = 1

Landfills contribute to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 2

Access roads to landfills provide opportunities for human access into desert areas.

Human Access variable (A_t) = 2

Cumulative and Interactive Effects

Landfills interact with six other threats, including being associated with urbanized areas and roads; the introduction of litter, toxins, and pollutants into desert environments; contributing to the spread of invasive plants; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 2

1.1.6 Anthropogenic Water Sources

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Anthropogenic water sources do not contribute to tortoise mortality.

Mortality variable (M_t) = 0

Certain anthropogenic water sources (especially human-made ponds and reservoirs) contribute significantly to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

Anthropogenic water sources do not provide opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Anthropogenic water sources interact with seven other threats, including the origination of water sources from urban areas, mines, livestock grazing, agricultural activities, and military activities; facilitating the spread of invasive plants; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 2

1.2 Human Actions and Activities

1.2.1 OHV Use

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

OHV use contributes to tortoise mortality through OHV vehicle-tortoise strikes, and crushing burrows, leading to entombment of tortoises.

Mortality variable (M_t) = 1

OHV use contributes significantly to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

OHV use provides opportunities for human access into desert areas adjacent to roads and OHV routes.

Human Access variable (A_t) = 3

Cumulative and Interactive Effects

OHV use interacts with 12 other threats, including the facilitation of OHV use from urban areas, roads, access roads to utilities, landfills, and mines; contributing to human collection and poaching of tortoises and poor air quality; introducing litter, toxins, and pollutants into desert environments; facilitating the spread of invasive plants and fire; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 3

1.2.2 Livestock Grazing

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Livestock grazing contributes to tortoise mortality through crushing burrows, leading to entombment of tortoises.

Mortality variable (M_t) = 1

Livestock grazing contributes moderately to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 2

Livestock grazing does not normally provide opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Livestock grazing interacts with four other threats, including contributing to anthropogenic water sources; facilitating the spread of invasive plants; changing vegetation communities in ways that make them more susceptible to fire; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 1

1.2.3 Agricultural Practices

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Agriculture contributes to tortoise mortality through crushing burrows, leading to entombment of tortoises.

Mortality variable (M_t) = 1

Agriculture contributes significantly to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 3

Agricultural activities do not normally provide opportunities for human access into adjacent desert areas.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Agriculture interacts with five other threats, including contributing to anthropogenic water sources and poor air quality; introduction of toxins and pollutants into desert environments; facilitating the spread of invasive plants; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 1

1.2.4 Mineral Extraction

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Mining activities contribute to tortoise mortality during construction, through trapping tortoises within mine shafts, and through tortoise-vehicle strikes along mine access roads.

Mortality variable (M_t) = 2

Mining activities contribute to the loss, degradation, and fragmentation of desert habitat.

Habitat variable (H_t) = 2

Access roads to mines provide opportunities for human access into desert areas.

Human Access variable (A_t) = 2

Cumulative and Interactive Effects

Mines interact with eight other threats, including being associated with access roads; facilitating OHV use and illegal dumping along access roads; providing anthropogenic water sources; the introduction of toxins and pollutants into desert environments; contributing to poor air quality and the spread of invasive plants; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 2

1.2.5 Military Activities

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Military activities may contribute substantially to tortoise mortality.

Mortality variable (M_t) = 3

Military activities may contribute substantially to habitat destruction.

Habitat variable (H_t) = 2

Military activities facilitate human access to desert environments.

Human Access variable (A_t) = 2

Cumulative and Interactive Effects

Military activities interact with 13 other threats, including providing urbanized settings, roads, landfills, and anthropogenic water sources on and in the vicinity of military bases; facilitating OHV use; necessitating translocation of tortoise populations; introducing litter, toxins, and pollutants into desert environments; contributing to poor air quality; and facilitating the spread of invasive plants, fires, subsidized predators, and disease.

Interactive variable (I_t) = 3

1.2.6 Litter and Illegal Dumping

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Litter and illegal dumping may contribute to tortoise mortality through ingestion of trash.

Mortality variable (M_t) = 1

Litter and illegal dumping may contribute to habitat degradation.

Habitat variable (H_t) = 1

Litter and illegal dumping does not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Litter and illegal dumping interacts with eight other threats, including being facilitated by urbanization, roads, landfills, and mines; being associated with OHV use and military activities; introduction of toxins and pollutants to desert areas; and providing subsidies to predators of desert tortoises.

Interactive variable (I_t) = 2

1.2.7 Toxin and Pollutant Deposition

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Toxins and pollutants may contribute substantially to tortoise mortality.

Mortality variable (M_t) = 2

Toxins and pollutants contribute substantially to habitat degradation.

Habitat variable (H_t) = 2

Toxins and pollutants do not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Toxins and pollutants interact with 11 other threats, including their origination from urbanized areas, roads, railroads, utilities, landfills, mines, OHV use, agricultural practices, military activities, and illegal dumping. Furthermore, toxins may be absorbed by plants that are ingested by tortoises, possibly contributing to disease.

Interactive variable (I_t) = 3

1.2.8 Degradation of Air Quality

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Poor air quality may contribute to tortoise mortality by exacerbating the effects of respiratory diseases.

Mortality variable (M_t) = 1

Poor air quality may contribute to the degradation of desert habitat as it interferes with plant photosynthesis, as well as increasing invasive plant biomass in areas of nitrogen deposition.

Habitat variable (H_t) = 2

Poor air quality does not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Air quality interacts with 13 other threats, as poor air quality originates from urbanized areas and vehicles using roads, railroads, landfills, mining activities, OHV use, agricultural practices, military activities, and wildfire; as well as possibly contributing to the effects of respiratory diseases. Air quality is affected by airborne toxins and pollutants, and airborne NO_X particles contribute to increased biomass of invasive plants.

Interactive variable (I_t) = 3

1.2.9 Climate Change

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Climate change may contribute substantially to tortoise mortality as drought conditions become more commonplace.

Mortality variable (M_t) = 3

Climate change may contribute significantly to the loss, degradation, and fragmentation of habitat.

Habitat variable (H_t) = 3

Climate change does not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Climate change interacts with five other threats, as it originates (on a local scale) primarily from urbanized areas and vehicles traveling on major roads. Its effects could lead to higher frequencies of wildfires and droughts, and contribute to the biomass and spread of invasive plants.

Interactive variable (I_t) = 1

1.2.10 Collection and Poaching by Humans

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Collection or poaching of tortoises by humans contributes substantially to tortoise mortality by removing tortoises from populations.

Mortality variable (M_t) = 3

Collection and poaching of tortoises may contribute to habitat destruction when tortoises are excavated from burrows.

Habitat variable (H_t) = 1

Collection and poaching of tortoises does not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Collection and poaching of tortoises by humans interacts with eights other threats, including urbanization and roads, including those associated with utilities, landfills, and mines; OHV use; translocation of tortoise populations; as well as possibly contributing to disease.

Interactive variable (I_t) = 2

1.2.11 Translocation of Tortoise Populations

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Translocation of tortoise populations by humans contributes substantially to tortoise mortality, as a portion of the translocated population dies.

Mortality variable (M_t) = 2

Translocation of tortoise populations by humans does not contribute to the loss, degradation, or fragmentation of desert habitat.

Habitat variable (H_t) = 0

Translocation of tortoise populations by humans does not facilitate human access to desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Translocation of tortoise populations by humans interacts with six other threats, including being a mitigation option for urban developments, utility developments, and military land expansion; increasing the chances for collection and poaching of tortoises by humans and predation by subsidized predators; as well as possibly contributing to disease.

Interactive variable (I_t) = 2

1.3 ENVIRONMENTAL/BIOLOGICAL FACTORS

1.3.1 Drought

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Drought likely contributes significantly to tortoise mortality.

Mortality variable (M_t) = 3

Drought does not contribute to significant loss, degradation, or fragmentation of habitat.

Habitat variable (H_t) = 0

Drought does not facilitate human access to desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Drought interacts with four other threats, as it may exacerbate the effects of disease and predation by subsidized predators, and could be more frequent as climate change affects the region. Agriculture could lower local water tables, further contributing to droughts at a local level.

Interactive variable (I_t) = 1

1.3.2 Fire

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Fire may contribute substantially to tortoise mortality.

Mortality variable (M_t) = 3

Fire contributes significantly to the loss, degradation, and fragmentation of habitat.

Habitat variable (H_t) = 3

Fire does not facilitate human access to desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Fire interacts with seven other threats, including originating from urban areas, roads, OHV use, and military activities; and contributing to poor air quality and the spread of invasive plants. Wildfires may become more common following climate change.

Interactive variable (I_t) = 2

1.3.3 Disease

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Disease contributes substantially to tortoise mortality.

Mortality variable (M_t) = 3

Disease does not contribute to the loss, degradation, or fragmentation of habitat.

Habitat variable (H_t) = 0

Disease does not facilitate human access to desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Disease interacts with nine other threats, as disease is more prevalent around human developments such as urbanized areas, roads, and developments on military training sites; may be more prevalent in areas affected by agricultural practices and livestock grazing; may be spread by collection and poaching by humans; and may be exacerbated by poor air quality, toxins within invasive plants, and droughts.

Interactive variable (I_t) = 2

1.3.4 Subsidized Predators

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Subsidized predators contribute substantially to tortoise mortality through increased predation pressure.

Mortality variable (M_t) = 3

Subsidized predators do not contribute to the loss, degradation, or fragmentation of habitat.

Habitat variable (H_t) = 0

Subsidized predators do not facilitate human access to desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Subsidized predators interact with 12 other threats, as subsidies are provided by human developments such as urbanized areas, roads, utilities, landfills, mines, and anthropogenic water sources; activities such as OHV use, agricultural practices, livestock grazing, litter and illegal dumping, and military activities may provide subsidies to predators; and droughts may lead to increased predation rates by subsidized predators.

Interactive variable (I_t) = 3

1.3.5 Invasive Plants

Effects on Tortoise Mortality, Tortoise Habitat, and Human Access

Invasive plants do not contribute substantially to tortoise mortality.

Mortality variable (M_t) = 0

Invasive plants contribute mildly to habitat degradation.

Habitat variable (H_t) = 1

Invasive plants do not facilitate human access into desert environments.

Human Access variable (A_t) = 0

Cumulative and Interactive Effects

Invasive plants interact with 14 other threats, as invasive plants originate from a variety of disturbances, including urbanized areas, roads, utilities, landfills, mining activities, OHV use, livestock grazing, agricultural practices, and military activities; they may be further spread by anthropogenic water sources and wildfires; they contain higher concentrations of toxins that may be ingested by tortoises, contributing to disease. Invasive plants contribute to the spread of wildfires, particularly in areas affected by nitrogen deposition.

Interactive variable (I_t) = 3

2. SPATIAL AND TEMPORAL DISTRIBUTIONS OF THREATS: GOLD BUTTE-PAKOON CONSERVATION AREA

2.1 HUMAN DEVELOPMENTS

2.1.1 Urbanization

Distribution/Severity of Threat within the Conservation Area

An examination of current human development within in-holdings on the Conservation Area identified several ranch house developments on in-holdings within the Pakoon Basin on the Arizona portion of the Conservation Area, collectively occupying 97 acres (0.00016% of the Conservation Area).

Distribution/severity variable (d) = 0.00016

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on developable topography (flat or bajada landforms) within parcels total 1,660 acres on private in-holdings in Nevada and 1,101 acres on private and state owned parcels in Arizona. Since 97 acres are already developed on in-holdings, an additional 2,664 acres could potentially be developed (0.44% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 0.44

Degree of Change of Threat

Using remote sensing techniques, we identified an area of change within the Conservation Area at the interface with the community of Scenic, Arizona (Figure E-1). The detected urbanization in this area is likely a function of the pixel size. While homes are not being built within the Conservation Area boundary, there are homes and roads that were constructed directly adjacent to the border, which resulted in the pixels being included within the Conservation Area boundaries. The amount of change attributed to urban development at this location was 9 acres during the period between 1990 and 2001, and 31 acres during the period between 2001 and 2008. However, since the development is actually outside the Conservation Area, it was not included as change within the Conservation Area.

Degree of Change variable (C_t) = 0.00

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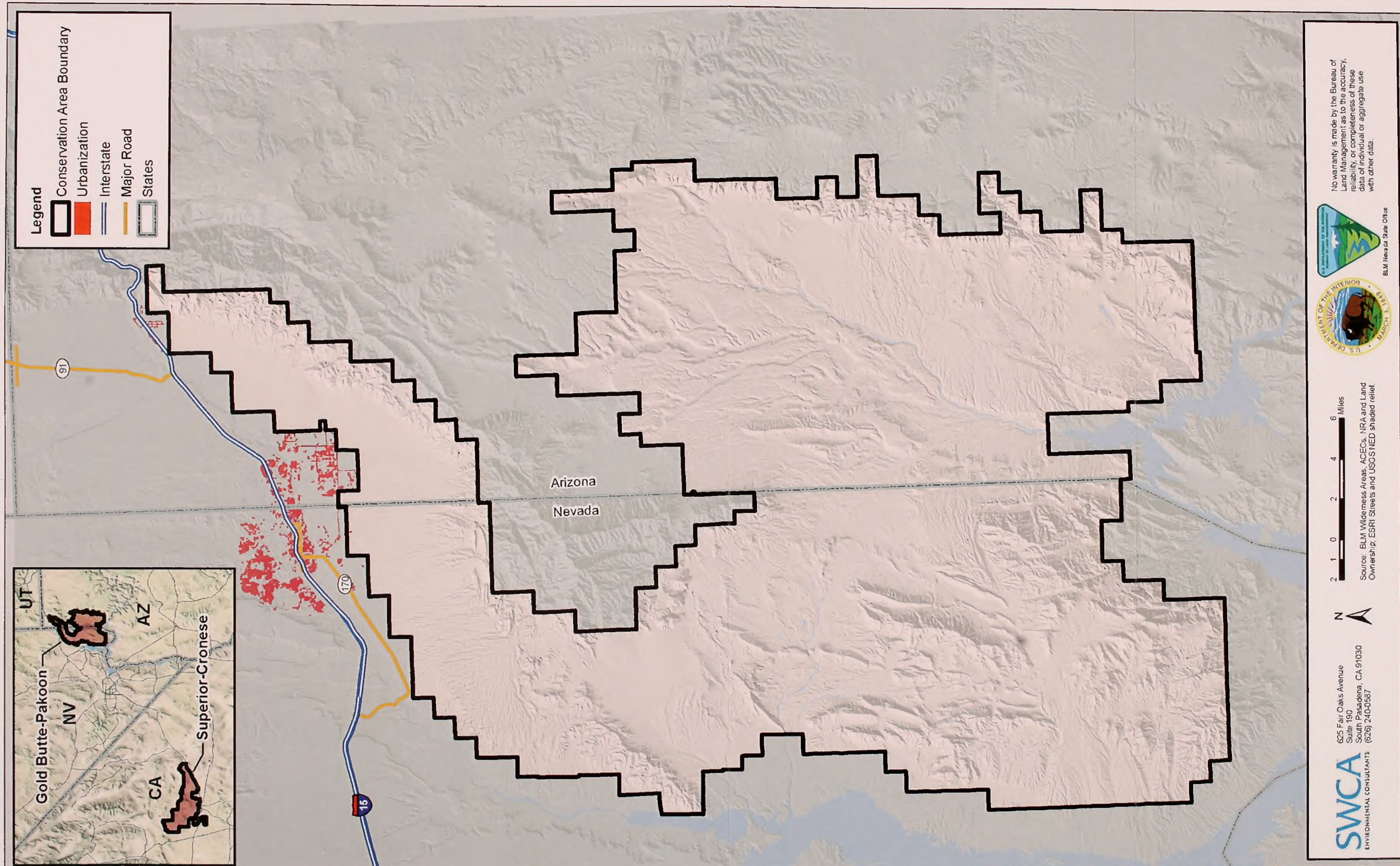

Figure E-1. Areas of change attributed to urbanization adjacent to the Gold Butte-Pakoon Conservation Area between 1990 and 2008, as determined using remote sensing techniques

2.1.2 Roads

Distribution/Severity of Threat within the Conservation Area

Several paved and graded roads occur within and adjacent to the Conservation Area. The largest road, Interstate 15, is located outside of the Conservation Area boundaries, and generally occurs within the Virgin River Valley outside of desert tortoise habitat. A number of other roads are situated just outside of the Conservation Area boundaries, including State Highway 170 and several County and municipal roads in the vicinity of Mesquite and other smaller communities within the Virgin River Valley. One paved two-lane road occurs within the Conservation Area boundaries (upper portion of the Gold Butte Backcountry Byway), as well as several graded dirt roads. To address the effects of roads on desert tortoise mortality, we mapped buffers around the roads to depict the potential desert tortoise 'mortality sinks' around them. We based the size of the buffers on data presented by von Seckendorff Hoff and Marlow (2002), as summarized in Table 8 of this report. Applying buffers around the roads that represent these potential mortality sinks (Figure E-2), we determined that 113,323 acres fall within the estimated mortality sinks, representing 18.54% of the Conservation Area.

Distribution/severity variable (d) = 18.54

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to roads was not detected.

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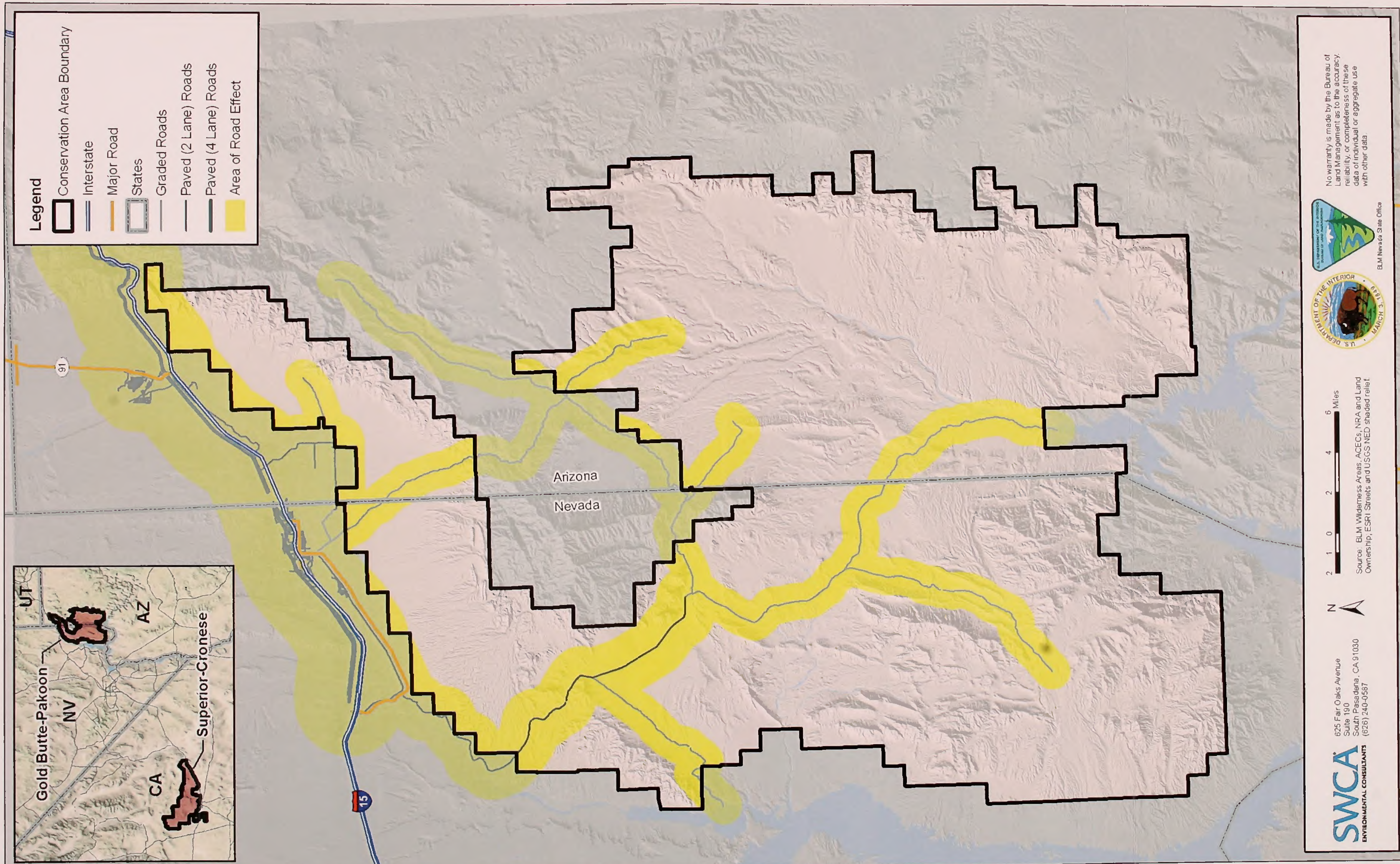

Figure E-2. Roads and road-effect (estimated mortality sink) buffers within and adjacent to the Gold Butte-Pakoon Conservation Area

2.1.3 Railroads

Distribution/Severity of Threat within the Conservation Area

There are no railroads within the Conservation Area.

Distribution/severity variable (d) = 0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.1.4 Utilities

Distribution/Severity of Threat within the Conservation Area

Utilities within the Conservation Area are limited to three communications towers, located in the southern portion of Gold Butte ACEC Part B, collectively occupying 0.069 acres (0.00000011% of Conservation Area). Additionally, a total of 0.5 miles of road accesses utilities exclusively within the Conservation Area, accounting for an additional 31.8 acres of effect (assuming a road effect of 50 meters from centerline of the road). Together these effects account for 0.0052% of the Conservation Area.

Distribution/severity variable (d) = 0.0052

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to utilities was not detected.

2.1.5 Landfills

Distribution/Severity of Threat within the Conservation Area

There are no landfills within the Conservation Area.

Distribution/severity variable (d) = 0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.1.6 Anthropogenic Water Sources

Distribution/Severity of Threat within the Conservation Area

Anthropogenic water sources within the Conservation Area include three human-made ponds and small portions of Lake Mead, accounting for 27 acres (0.000044% of the Conservation Area).

Distribution/severity variable (d) = 0.000044

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to anthropogenic water sources was not detected.

2.2 HUMAN ACTIONS AND ACTIVITIES

2.2.1 OHV Use

Distribution/Severity of Threat within the Conservation Area

A total of 860.7 linear miles of routes are currently designated within the Conservation Area. Assuming a road effect of 50 meters from centerline of the road, 34,228.1 acres (5.60% of the Conservation Area) are affected by OHV use.

Distribution/severity variable (d) = 5.60

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change attributed to OHV use within the Conservation Area (Figure E-3). The detected OHV use was confirmed through examination of Google Earth aerial photos, maps of OHV trails distributed by the Nevada OHV Association, and through ground truthing. The amount of change attributed to OHV use within the Conservation Area was 647 acres during the period between 1990 and 2001, and 3,810 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.043

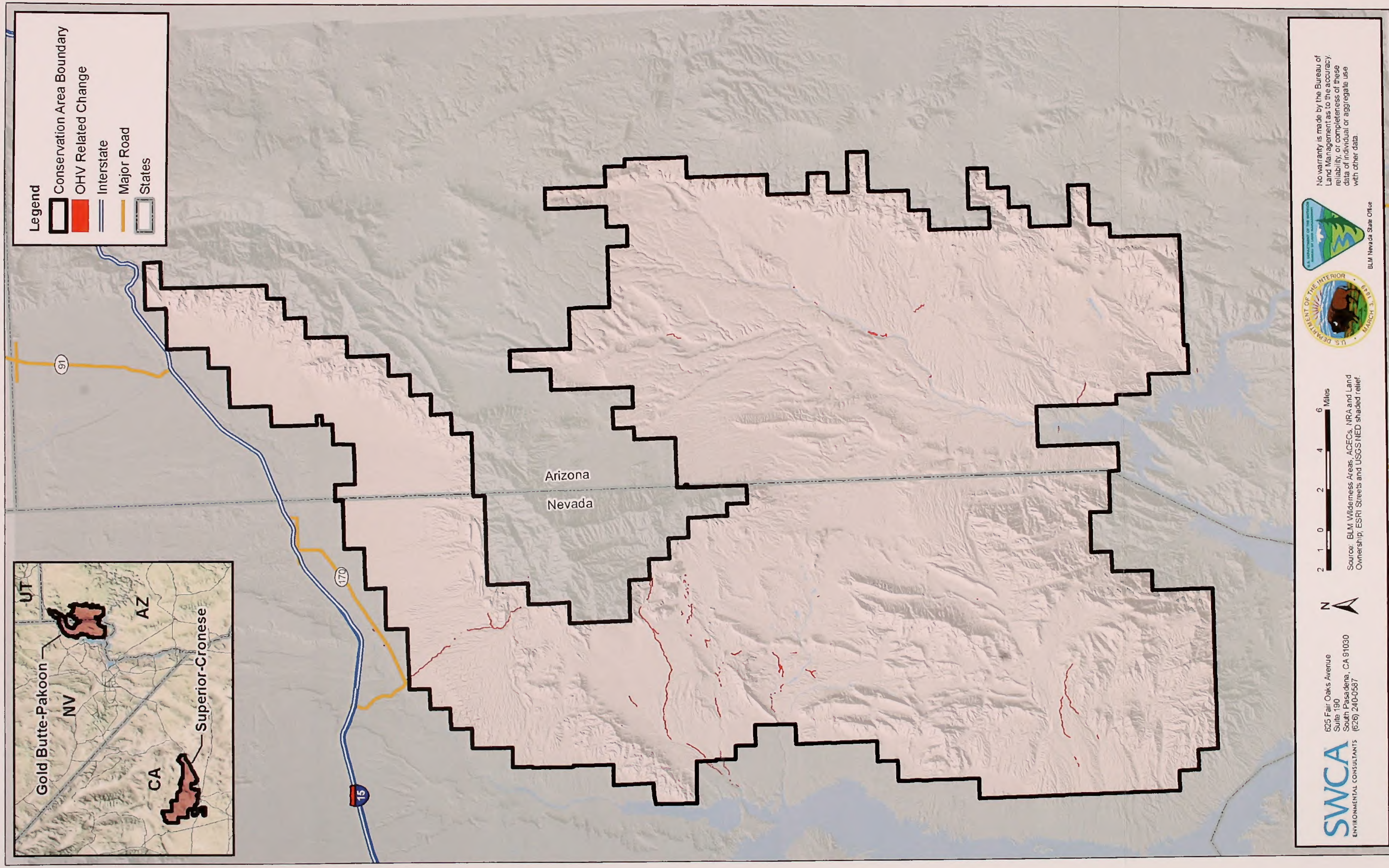

Figure E-3. Areas of change attributed to OHV use within and adjacent to the Gold Butte-Pakoon Conservation Area between 1990 and 2008, as determined using remote sensing techniques

2.2.2 Livestock Grazing

Distribution/Severity of Threat within the Conservation Area

Active grazing allotments currently occur on 166,181 acres of the Arizona portion of the Conservation Area. Additional grazing by trespass cattle and feral burros occur over significant areas of the Conservation Area. We estimate that the entire Conservation Area (100% of the Conservation Area) is affected by livestock grazing.

Distribution/severity variable (d) = 100.00

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change attributed to livestock grazing within the Conservation Area (Figure E-4). The amount of change attributed to livestock grazing within the Conservation Area was 1,160 acres during the period between 1990 and 2001, and 10,579 acres during the period between 2001 and 2008. Though grazing allotments have been closed for the entire Nevada portion and significant areas within the Arizona portion of the Conservation Area, trespass is prevalent throughout; therefore, as closure of grazing allotments have not been fully implemented, no change is attributed to these measures.

Degree of Change variable (C_t) = 0.173

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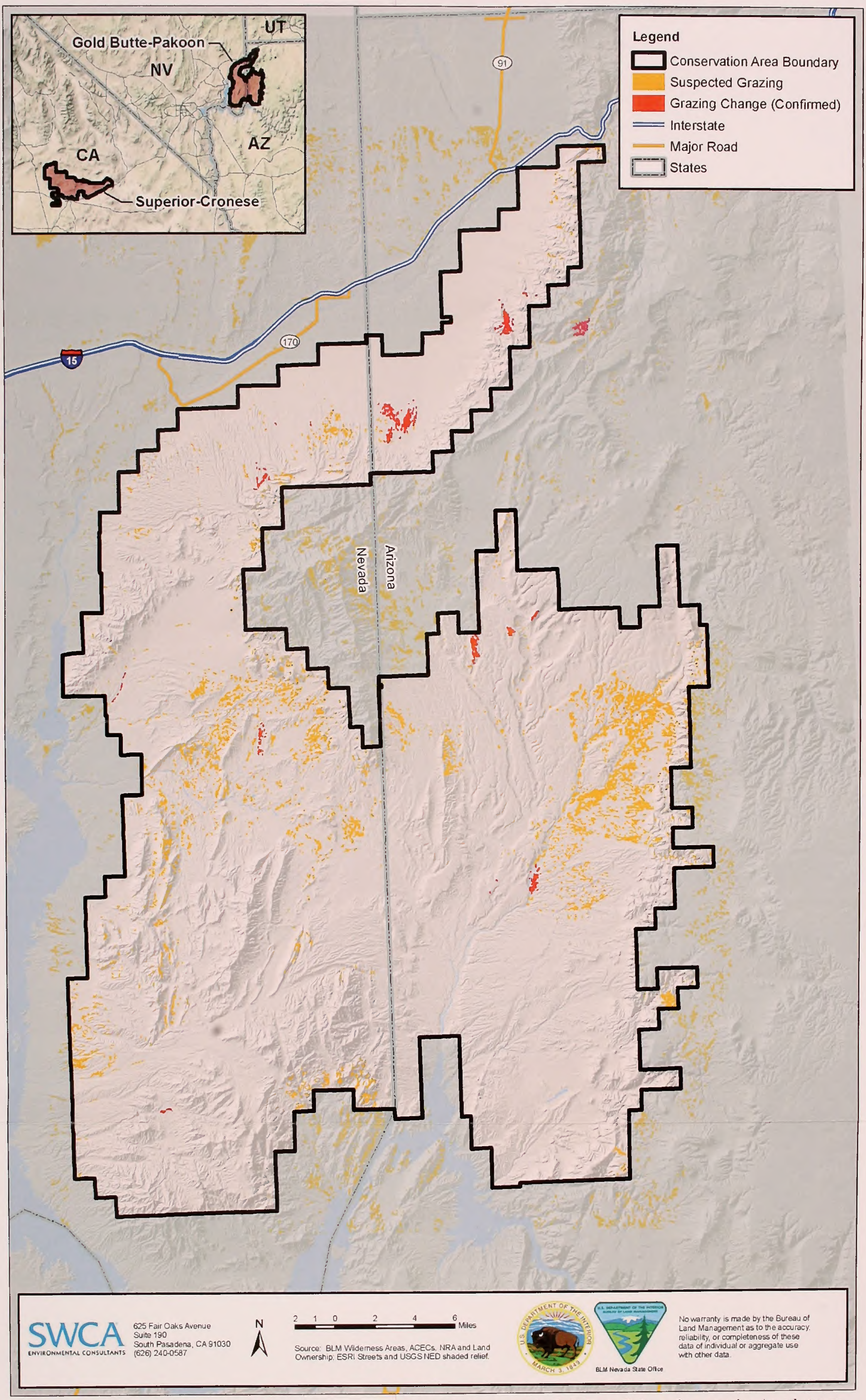

Figure E-4. Areas of change attributed to livestock grazing within and adjacent to the Gold Butte-Pakoon Conservation Area between 1990 and 2008, as determined using remote sensing techniques

2.2.3 Agricultural Practices

Distribution/Severity of Threat within the Conservation Area

Agricultural fields occur over 26 acres within the Conservation Area (0.000425% of the Conservation Area).

Distribution/severity variable (d) = 0.000425

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on developable topography (flat or bajada landforms) within parcels total 1,660 acres on private in-holdings in Nevada and 973 acres on private and state owned parcels in Arizona. Since 26 acres have already been converted to agricultural use, a maximum of 2,607 additional acres could be converted (0.43% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 0.43

Degree of Change of Threat

Change attributable to agricultural activities was not detected.

2.2.4 Mineral Extraction

Distribution/Severity of Threat within the Conservation Area

Mines and mineral extraction sites account for approximately 18 acres within the Conservation Area. Additionally, a total of 16.2 miles of roads/trails access mines exclusively within the Conservation Area, accounting for an additional 644 acres of effect (assuming a road effect of 50 meters from centerline of the road). Together these effects account for 0.11% of the Conservation Area.

Distribution/severity variable (d) = 0.11

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on topography conducive to mineral extraction (hill or mountain landforms) within parcels total 6,579 acres on private in-holdings in Nevada and 1,424 acres on private and state owned parcels in Arizona (1.31% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 1.31

Degree of Change of Threat

Change attributable to mining was not detected.

2.2.5 Military Activities

Distribution/Severity of Threat within the Conservation Area

There are no military activities within the Conservation Area.

Distribution/severity variable (d) = 0.0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.2.6 Litter and Illegal Dumping

Distribution/Severity of Threat within the Conservation Area

Because litter and illegal dumping occurs primarily in areas accessed by humans, the distribution of likely dump sites will be associated with human developments, including desert habitats adjacent to urbanized areas. In particular, roads and trails leading from urban areas into the Conservation Area are likely the sites of illegal dumping. We estimated the areas most subject to dumping activities along these roads and trails within a buffer area of urban developments. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3000 m for high density urban developments. Using this technique, we determined that 39.6 miles of roads and trails occur within the buffers, accounting for 1,574.8 acres (0.258% of the Conservation Area) of area of likely dump sites assuming a 50 m buffer from the centerline of the roads and trails leading from urbanized areas (Figure E-5).

Distribution/severity variable (d) = 0.258

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

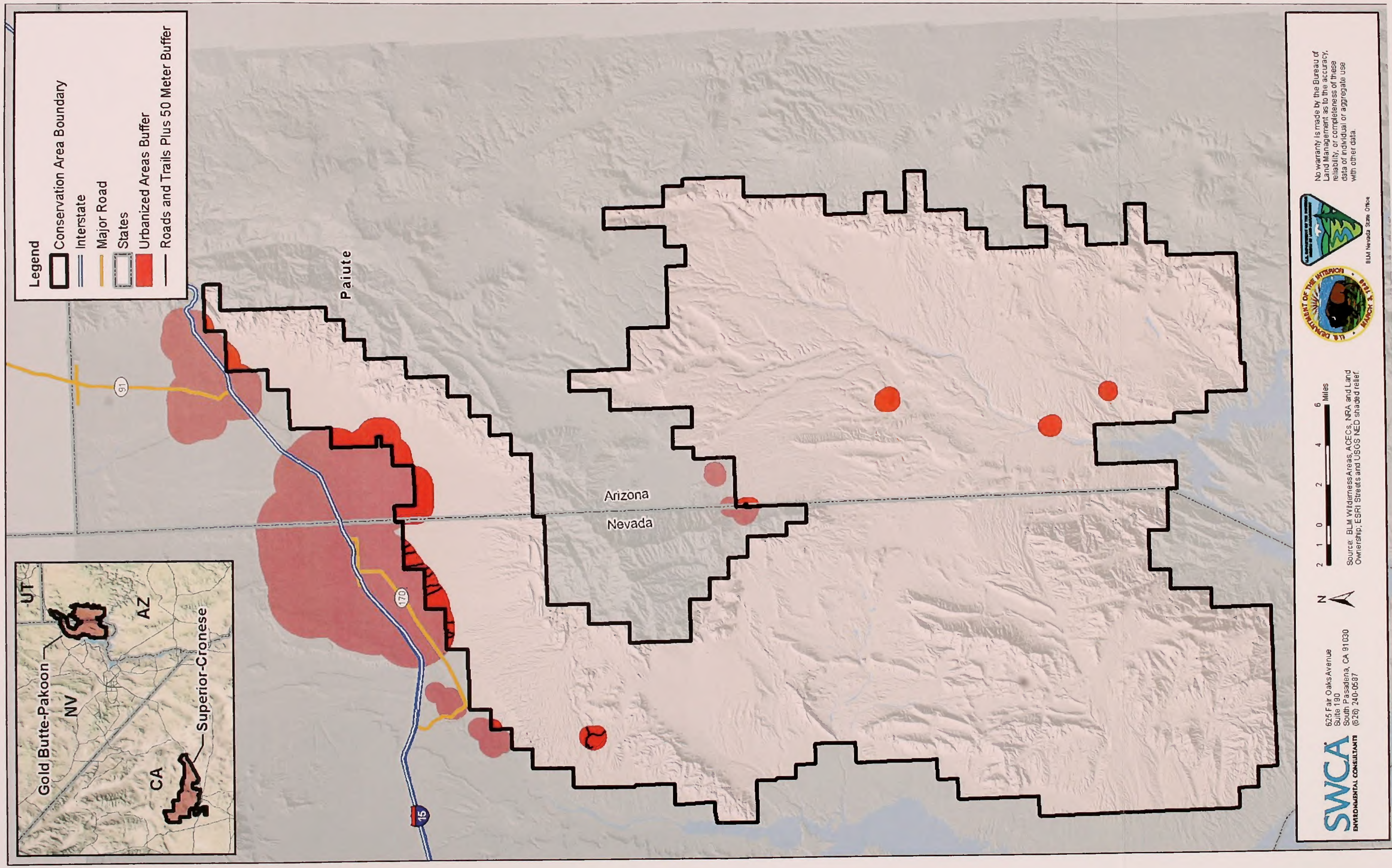

Figure E-5. Predicted areas of illegal dumping (along roads originating from urbanized areas) within the Gold Butte-Pakoon Conservation Area

2.2.7 Toxin and Pollutant Deposition

Distribution/Severity of Threat within the Conservation Area

Because deposition of toxins and pollutants occurs primarily in areas accessed by humans, the distribution of likely deposition sites and pollution sources will be associated with human developments and activity areas. Roads and trails leading from urban areas into the Conservation Areas are likely the sites of illegal dumping, which may contribute to toxin deposition. Other sites that likely introduce pollutants into desert environments include mines, landfills, and military activity areas. We determined the areas likely affected by toxin and pollutant deposition by placing a 50 m buffer around roads and trails leading from urbanized areas (as with litter and illegal dumping), and a 100 m buffer around mines, landfills, and military activity areas. Using this technique, we determined that a total 2,417.7 acres (1,574.8 acres along roads from urban areas and an additional 842.9 acres around mines; 0.40% of the Conservation Area) were the likely areas for toxin and pollutant deposition (Figure E-6).

Distribution/severity variable (d) = 0.40

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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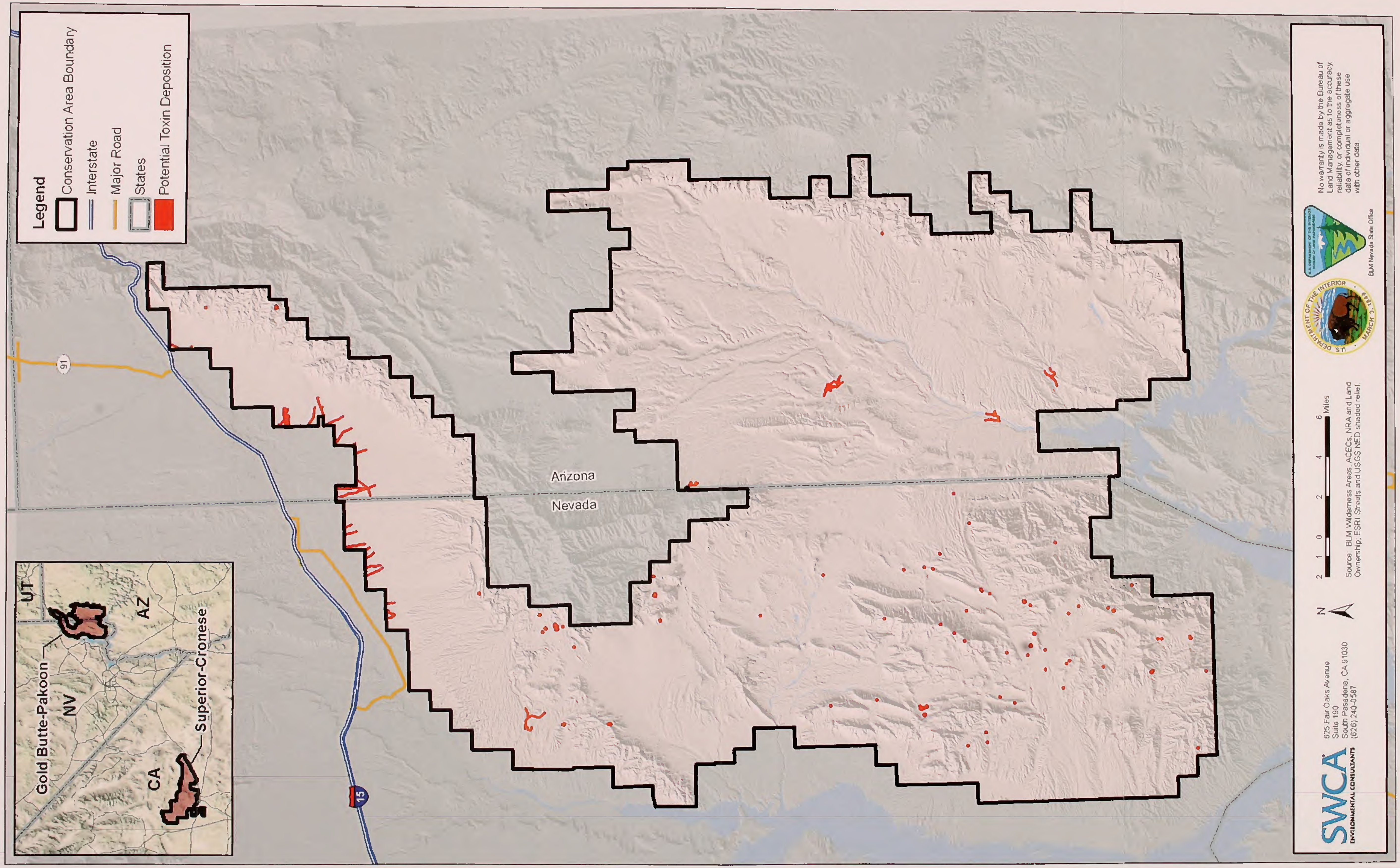

Figure E-6. Predicted areas of toxin and pollutant deposition within the Gold Butte-Pakoon Conservation Area

2.2.8 Degradation of Air Quality

Distribution/Severity of Threat within the Conservation Area

Air quality within the Conservation Area is affected primarily by particulates originating from Las Vegas and Mesquite, and fugitive dust produced by disturbances within and adjacent to the Conservation Area. Poor air quality within the Conservation Area is difficult to estimate without detailed data. However, we predict that nitrogen deposition will affect desert environments within 5,000 m of major urban areas and 2,000 m of major interstates. Using this technique, we determined that approximately 10,403 acres (1.70% of the Conservation Area) are affected by higher nitrogen deposition rates (Figure E-7).

Distribution/severity variable (d) = 1.70

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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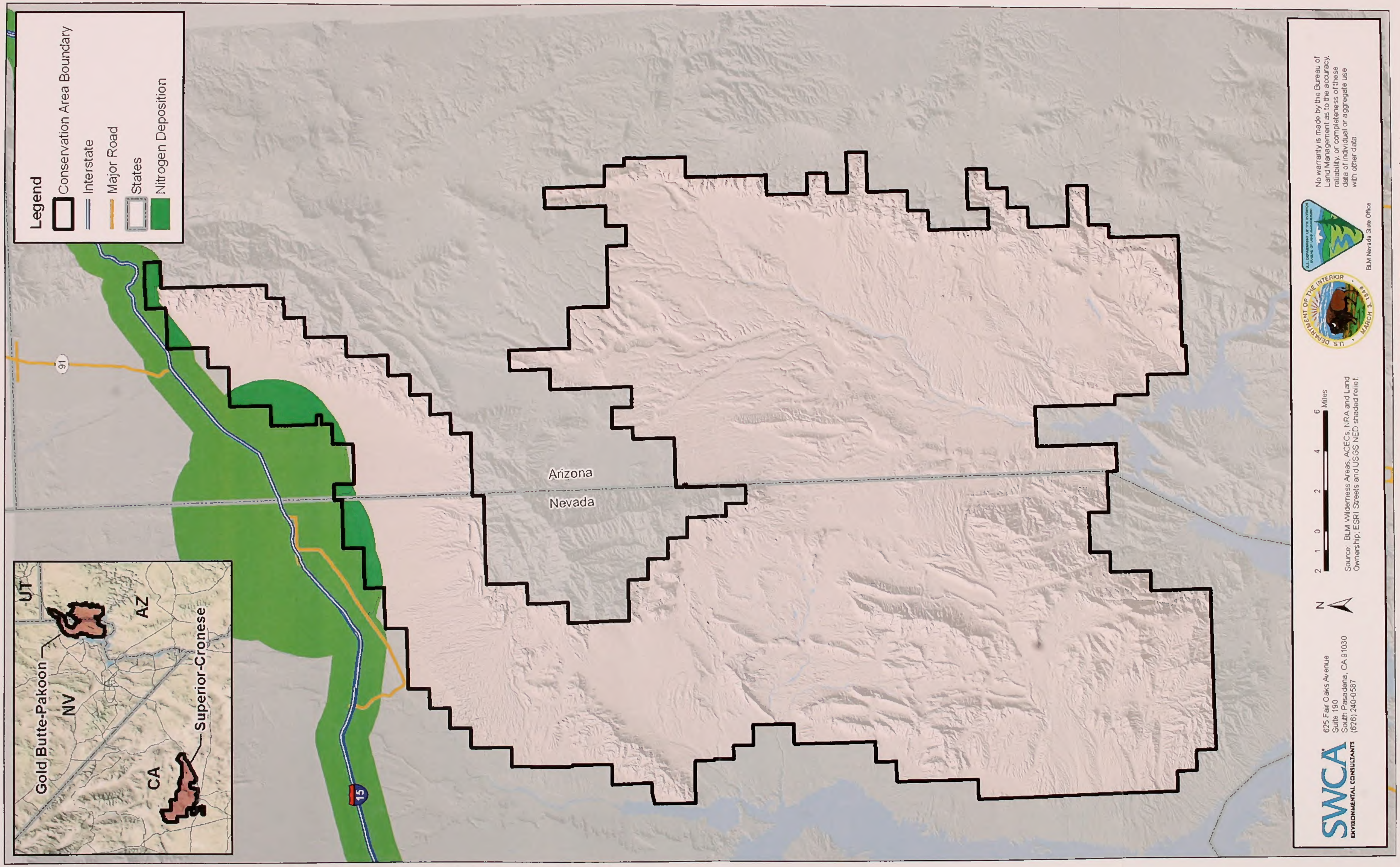

Figure E-7. Predicted area of high nitrogen deposition within the Gold Butte-Pakoon Conservation Area

2.2.9 Climate Change

Distribution/Severity of Threat within the Conservation Area

Climate change may affect desert environments within the Conservation Area by increasing the frequencies of wildfire and drought, as well as change the elevation limits of vegetation communities that define desert tortoise habitat. We examined the effect of raising the preferred elevation limits of desert tortoise (lower and upper) by 318 m, a figure predicted as a consequence of a rise in mean global temperatures by 2°C by the year 2050 (Bare et al 2009). We modeled the predicted change in elevation of desert tortoise habitat, and determined that there would be no areas excluded from the current habitat model. We also examined the effects of climate change on increased frequencies of wildfire and drought. For each, we estimated frequencies of an additional 20% over frequencies observed between 1990 and 2008.

Tortoise Distribution: Distribution/severity variable (d) = 0

Wildfire: Distribution/severity variable (d) = 41.5

Drought: Distribution/severity variable (d) = 20.0

Mean (d) = 20.5

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.2.10 Collection and Poaching by Humans

Distribution/Severity of Threat within the Conservation Area

Because collection and poaching of desert tortoises by humans occurs primarily in areas accessed by humans, the distribution of likely tortoise collection areas will be associated with human developments and activity areas, including urbanized areas and OHV routes, as well as adjacent desert habitats in the vicinity of these developments and activity areas. We estimated the areas most vulnerable to tortoise collection and poaching activities along roads within the Conservation Area by determining the linear miles of routes within modeled desert tortoise habitat, and determining acreages along these routes by providing a 50 m buffer on the centerline of these roads. Using this technique, we determined that 679.1 miles of roads and trails occur within modeled desert tortoise habitat, accounting for 27,006.3 acres of area assuming a 50 m buffer from the centerline of the road. We further estimated the effect of urbanized areas on collection and poaching of tortoises by humans by determining acreage of desert tortoise habitat within a buffer of urban developments. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3000 m for high density urban developments. We calculated the acreage within these buffers to be 11,077 acres within the Conservation Area. Therefore, the predicted area of vulnerability to collection and poaching of tortoises by humans occurs over 38,083.3 acres (6.23% of the Conservation Area).

Distribution/severity variable (d) = 6.23

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.2.11 Translocation of Populations

Distribution/Severity of Threat within the Conservation Area

There are no ongoing or planned translocations of tortoise populations within the Conservation Area.

Distribution/severity variable (d) = 0.0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.3 ENVIRONMENTAL/BIOLOGICAL FACTORS

2.3.1 Drought

Distribution/Severity of Threat within the Conservation Area

During the period under study (1990 through 2008), there were no droughts (accumulations of less than 25 mm) recorded within the Conservation Area for either winter or summer precipitation accumulations. We predict that droughts are rare within the Conservation Area.

Distribution/severity variable (d) = 0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

2.3.2 Fire

Distribution/Severity of Threat within the Conservation Area

Fire has affected considerable portions of the Conservation Area. Wildfires have been mapped over 209,133.3 acres (34.21% of Conservation Area) between 1990 and 2008.

Distribution/severity variable (d) = 34.21

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change due to wildfire within the Conservation Area (Figure E-8). The amount of change attributed to wildfire was 1,374 acres during the period between 1990 and 2001, and 51,904 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 3.29

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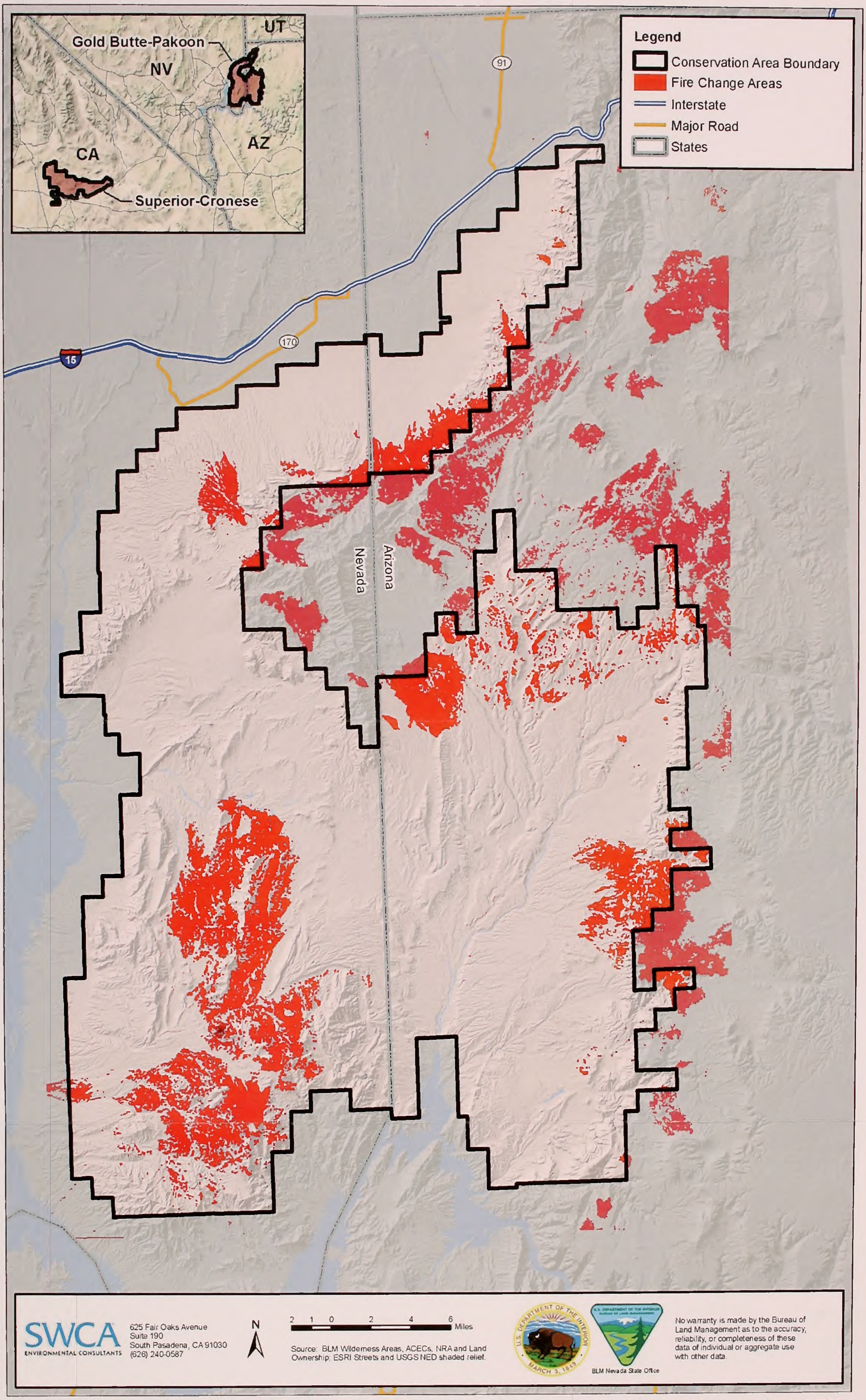

Figure E-8. Areas of change attributed to fire within and adjacent to the Gold Butte-Pakoon Conservation Area between 1990 and 2008, as determined using remote sensing techniques

2.3.3 Disease

Distribution/Severity of Threat within the Conservation Area

The threat of disease is unknown within the Conservation Area. Since studies in other portions of the range of the desert tortoise indicate that tortoise populations in proximity to urban areas suffer from higher rates of URTD incidence, we estimated the probability of occurrence within the Conservation Area by placing a buffer around urban areas. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3000 m for high density urban developments. Using this technique we estimated the acreage within urban area buffers to be 11,077 acres and road buffer acreage to be 2,137 acres, totaling 13,214 acres where higher disease incidence is expected to occur within the Conservation Area (2.16% of the Conservation Area).

Distribution/severity variable (d) = 2.16

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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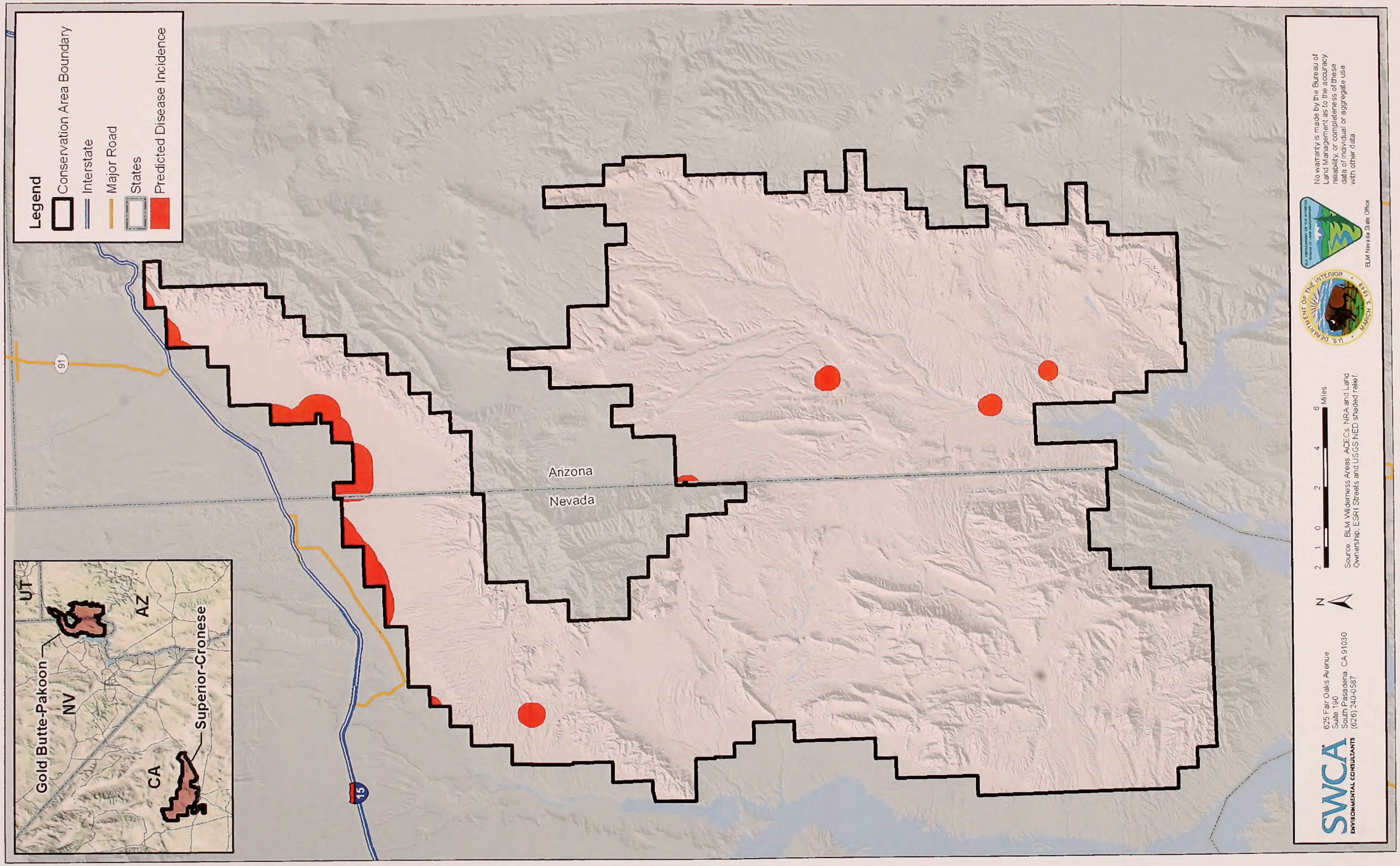

Figure E-9. Predicted area of increased probability of disease incidence within the Gold Butte-Pakoon Conservation Area

2.3.4 Subsidized Predators

Distribution/Severity of Threat within the Conservation Area

We estimated the probability for occurrence of subsidized predators by placing a buffer around features that provide subsidies for ravens, coyotes, and other subsidized predators. Based upon information provided in Boarman and Kristan (2006), we included a buffer of 4.46 kilometers from urbanized areas, landfills, open sources of anthropogenic water, major highways, and agricultural fields. Using this technique, we predicted an area of 154,971 acres (25.32% of the Conservation Area) that would support higher densities of predators based upon human subsidies (Figure E-10).

Distribution/severity variable (d) = 25.32

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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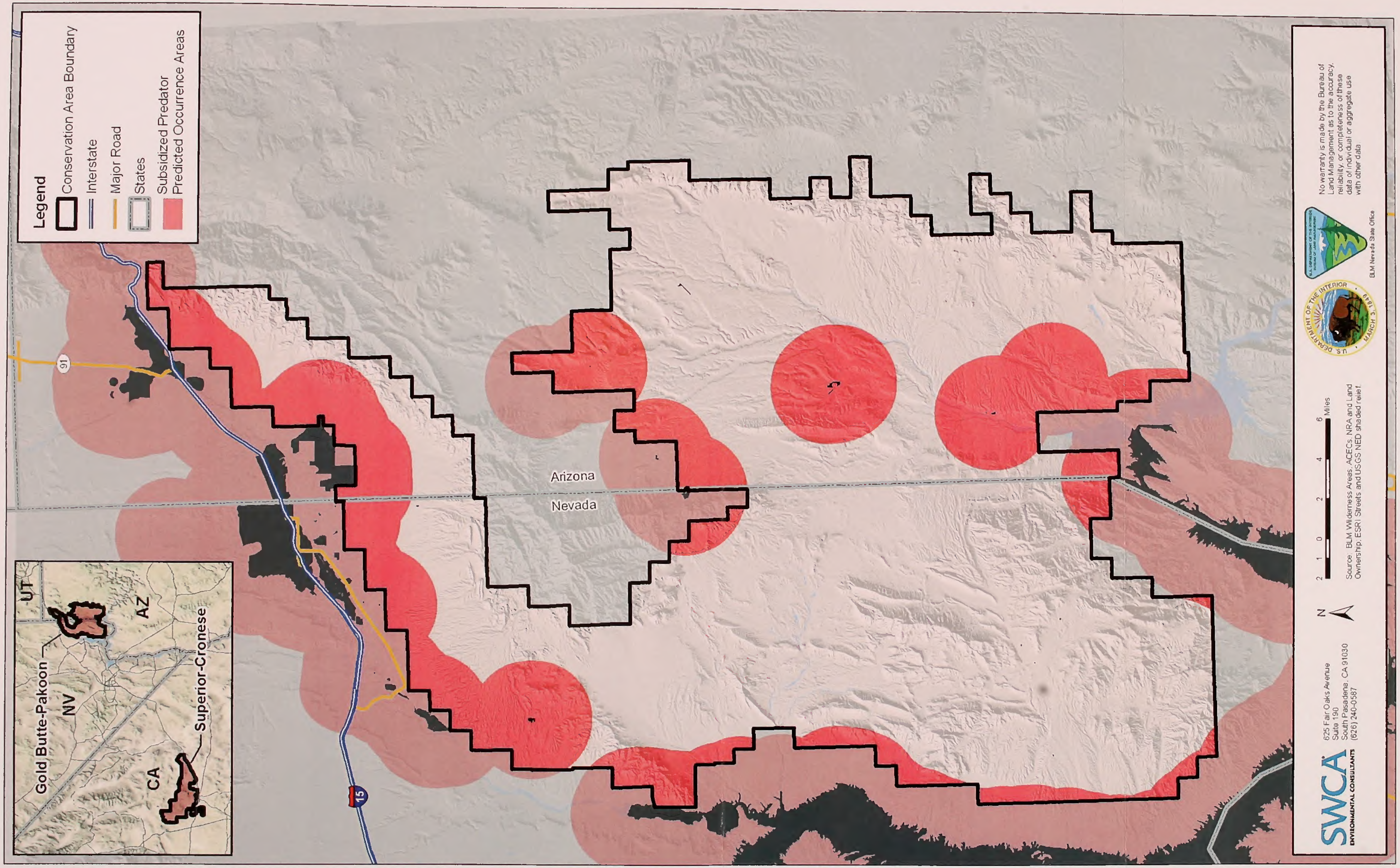

Figure E-10. Predicted occurrence area for predator populations subsidized by anthropogenic food and water sources

2.3.5 Invasive Plants

Distribution/Severity of Threat within the Conservation Area

Invasive plants appear to be present throughout the entire Conservation Area, though abundances appear to differentially distributed, i.e, invasive species biomass is greater in areas affected by soil disturbances and nitrogen deposition. Without detailed data we assume that the entire Conservation Area is affected by invasive plants (100.0% of the Conservation Area).

Distribution/severity variable (d) = 100.00

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

3. SPATIAL AND TEMPORAL DISTRIBUTIONS OF THREATS: SUPERIOR-CRONESE CONSERVATION AREA

3.1 Human Developments

3.1.1 Urbanization

Distribution/Severity of Threat within the Conservation Area

Urbanization in the vicinity of the Conservation Area includes several communities along the I-15 corridor, including Barstow, Lenwood, Hinkley, Calico, Yermo, and Harvard. In addition to urbanization outside of the Conservation Area boundaries, there are numerous ranch communities and single-home ranch developments on private in-holdings within the Conservation Area, particularly in the vicinity of Hinkley and Harvard. An examination of current human development within in-holdings on the Conservation Area identified several low density residential developments and ranch house developments on in-holdings in the vicinity of Hinkley, Harvard, and along Fort Irwin Road north of Coyote Dry Lake, collectively occupying 2,037 acres (0.3235% of the Conservation Area).

Distribution/severity variable (d) = 0.3235

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on developable topography (flat or bajada landforms) within parcels total 131,370 acres on private in-holdings. Since 2,037 acres are already developed on in-holdings, an additional 129,333 acres could potentially be developed (20.53% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 20.53

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change within the Conservation Area that were attributed to urban development (Figure E-11). The amount of change attributed to urban development at this location was 15 acres during the period between 1990 and 2001, and 42 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.00025

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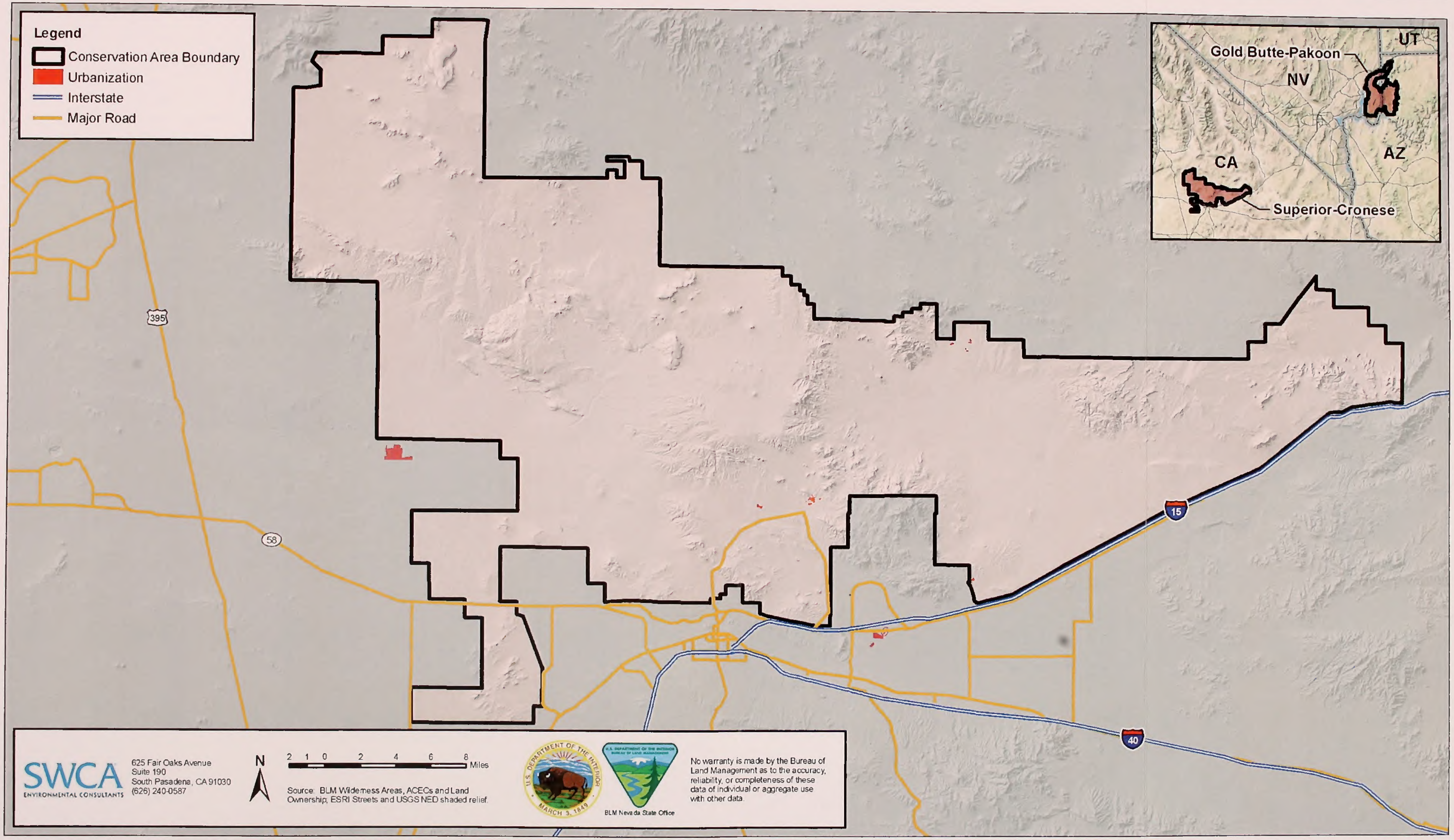

Figure E-11. Areas of change attributed to urbanization within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.1.2 Roads

Distribution/Severity of Threat within the Conservation Area

Numerous paved and graded dirt roads occur within and adjacent to the Conservation Area. The largest road, Interstate 15, is located along the southern of the Conservation Area boundaries. A number of other major roads occur within the Conservation Area boundaries, including State Highway 58, Fort Irwin Road, Manix Trail, and numerous other roads associated with the urbanized areas within and adjacent to the Conservation Area. To address the effects of roads on desert tortoise mortality, we mapped buffers around the roads to depict the potential desert tortoise 'mortality sinks' around them. We based the size of the buffers on data presented by von Seckendorff Hoff and Marlow (2002), as summarized in Table 8 of this report. Applying buffers around the roads that represent these potential mortality sinks, we determined that 201,554 acres fall within the estimated mortality sinks, representing 32.01% of the Conservation Area (Figure E-12). Portions of Interstate 15, Highway 58, and Fort Irwin Road were fenced with tortoise-proof fencing during the period of study (1990-2008), reducing the potential for these roads to contribute to desert tortoise mortality to 163,106 acres (25.89% of the Conservation Area; Figure E-13).

Distribution/severity variable (d) = 25.89

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change within the Conservation Area that were attributed to road construction, widening, or paving (Figure E-14). The amount of change attributed to road improvements totaled 0 acres during the period between 1990 and 2001, and 771 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.944

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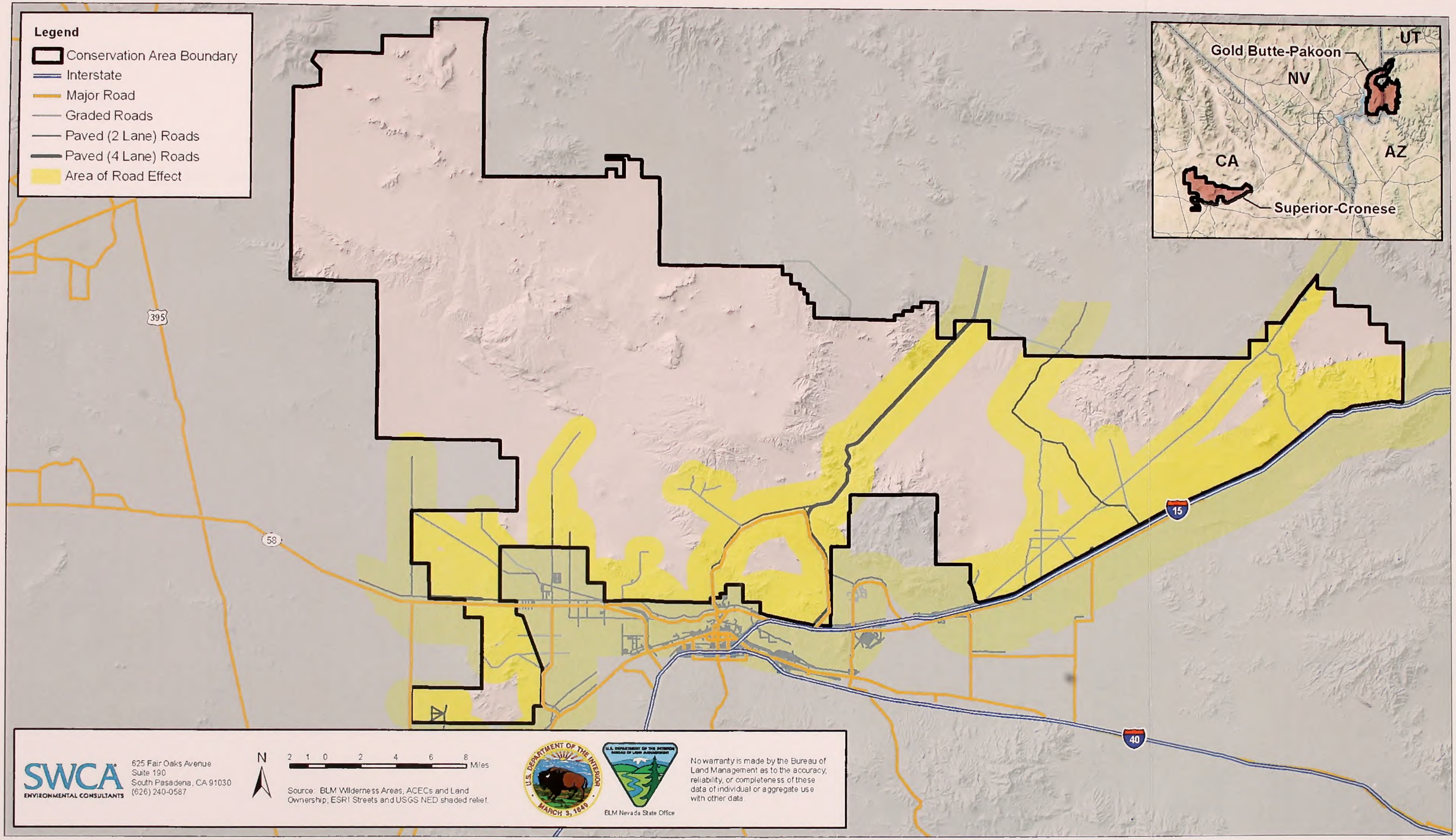

Figure E-12. Roads and road-effect (estimated mortality sink) buffers within and adjacent to the Superior-Cronese Conservation Area prior to tortoise-proof fence installation

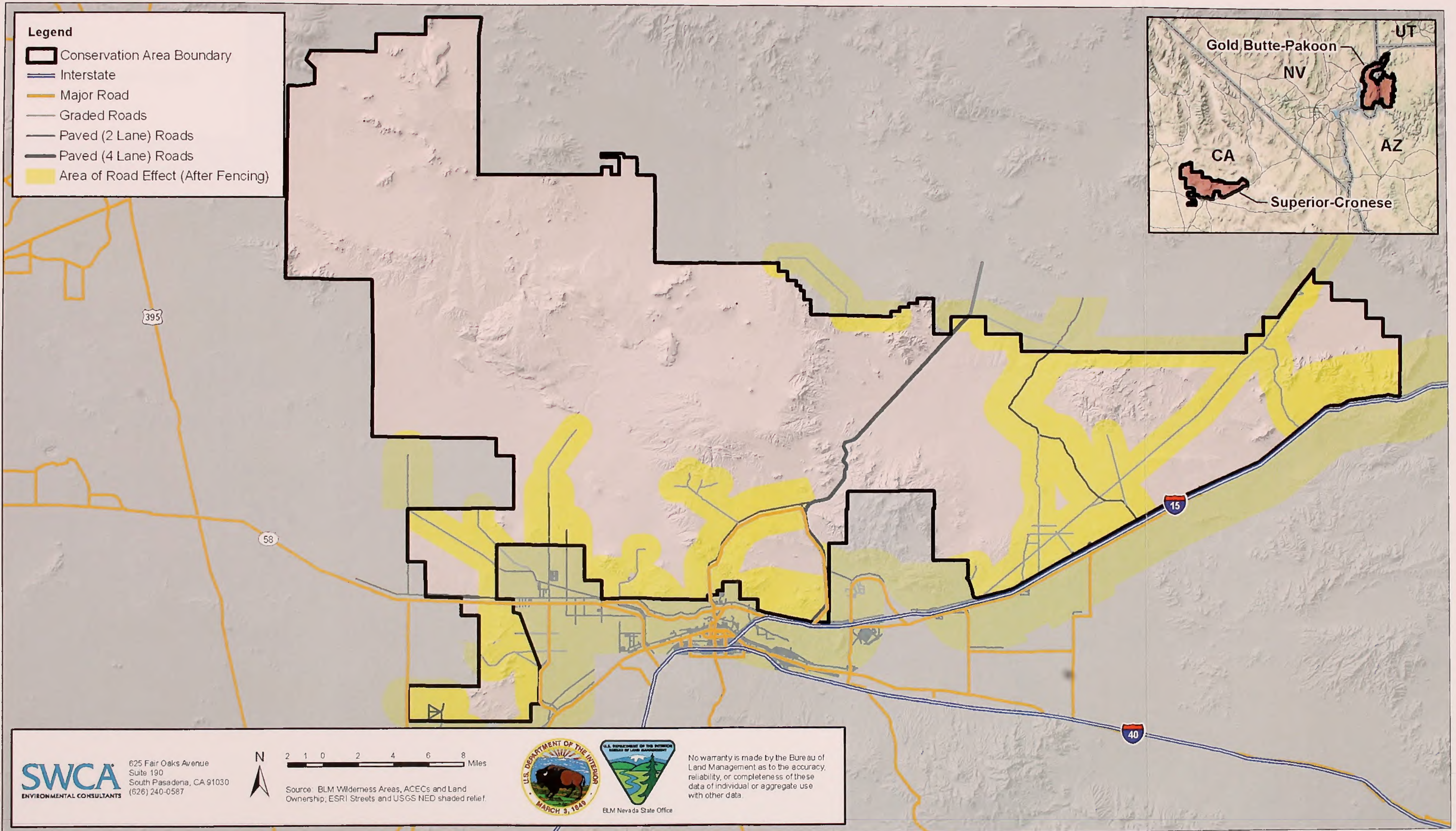

Figure E-13. Roads and road-effect (estimated mortality sink) buffers within and adjacent to the Superior-Cronese Conservation Area after tortoise-proof fence installation on Interstate 15, Highway 58, and Fort Irwin Road

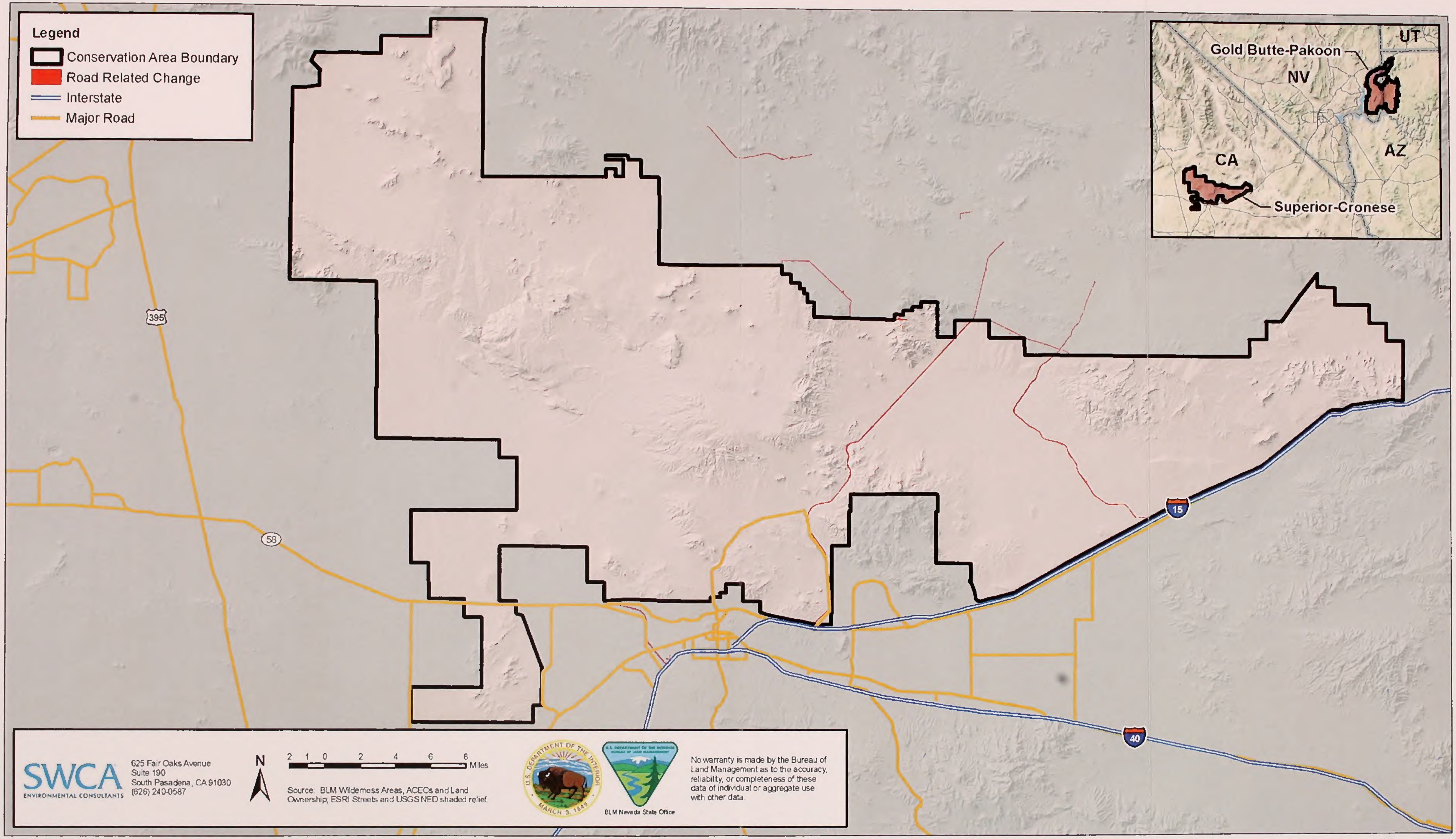

Figure E-14. Areas of change attributed to road construction, paving, or widening within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.1.3 Railroads

Distribution/Severity of Threat within the Conservation Area

Two railroads traverse the southern portion of the Conservation Area. Though these linear features occupy a small area, they present a significant barrier to tortoise movement, and may result in desert tortoise mortality similarly to roads. Assuming that the railroads contribute to mortality of desert tortoises in a manner similar to a 2-lane paved highway, we estimate the mortality sink would occur over 24,815 acres within the Conservation Area (3.94% of the Conservation Area) (Figure E-15).

Distribution/severity variable (d) = 3.94

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to railroad development or maintenance was not detected.

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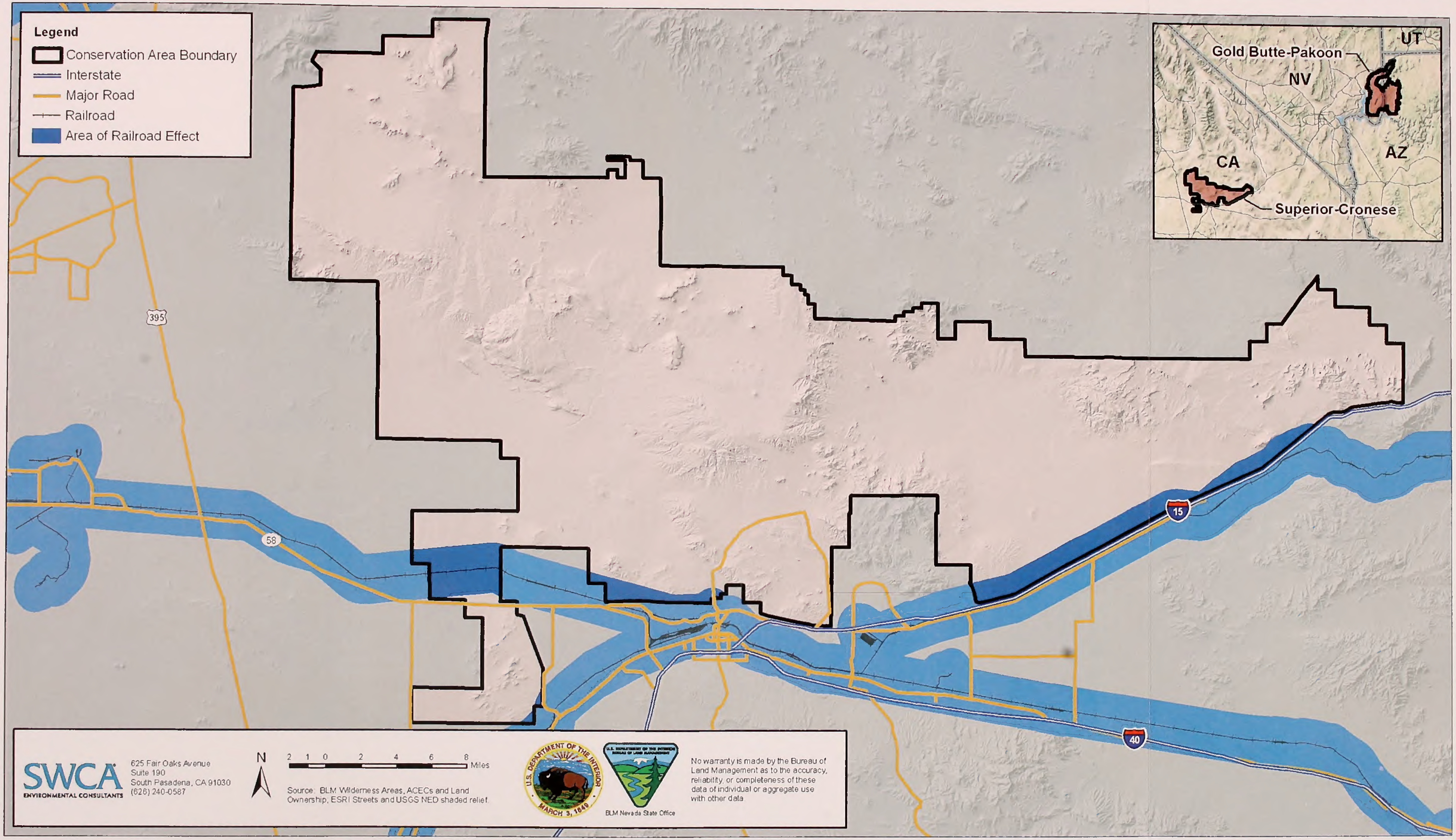

Figure E-15. Railroads and railroad-effect (estimated mortality sink) buffers within and adjacent to the Superior-Cronese Conservation Area

3.1.4 Utilities

Distribution/Severity of Threat within the Conservation Area

Utilities within the Conservation Area consist of 31.7 miles of underground utilities (primarily gas pipelines and fiber optic cables), 141.5 overhead utilities (primarily electric transmission lines), and two point utilities (consisting of a radio facility and an electrode facility). Assuming a 100-ft width on the underground utilities, they occupy an area of 384.2 acres. Overhead utilities account for 4,740 acres. The point utilities occupy 2.5 acres. Utilities account for 5,126.7 acres or 0.81% of the Conservation Area.

Distribution/severity variable (d) = 0.81

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change within the Conservation Area attributed to development of electrical transmission lines (Figure E-16). The amount of change detected was 66 acres during the period between 1990 and 2001, and 398 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.0044

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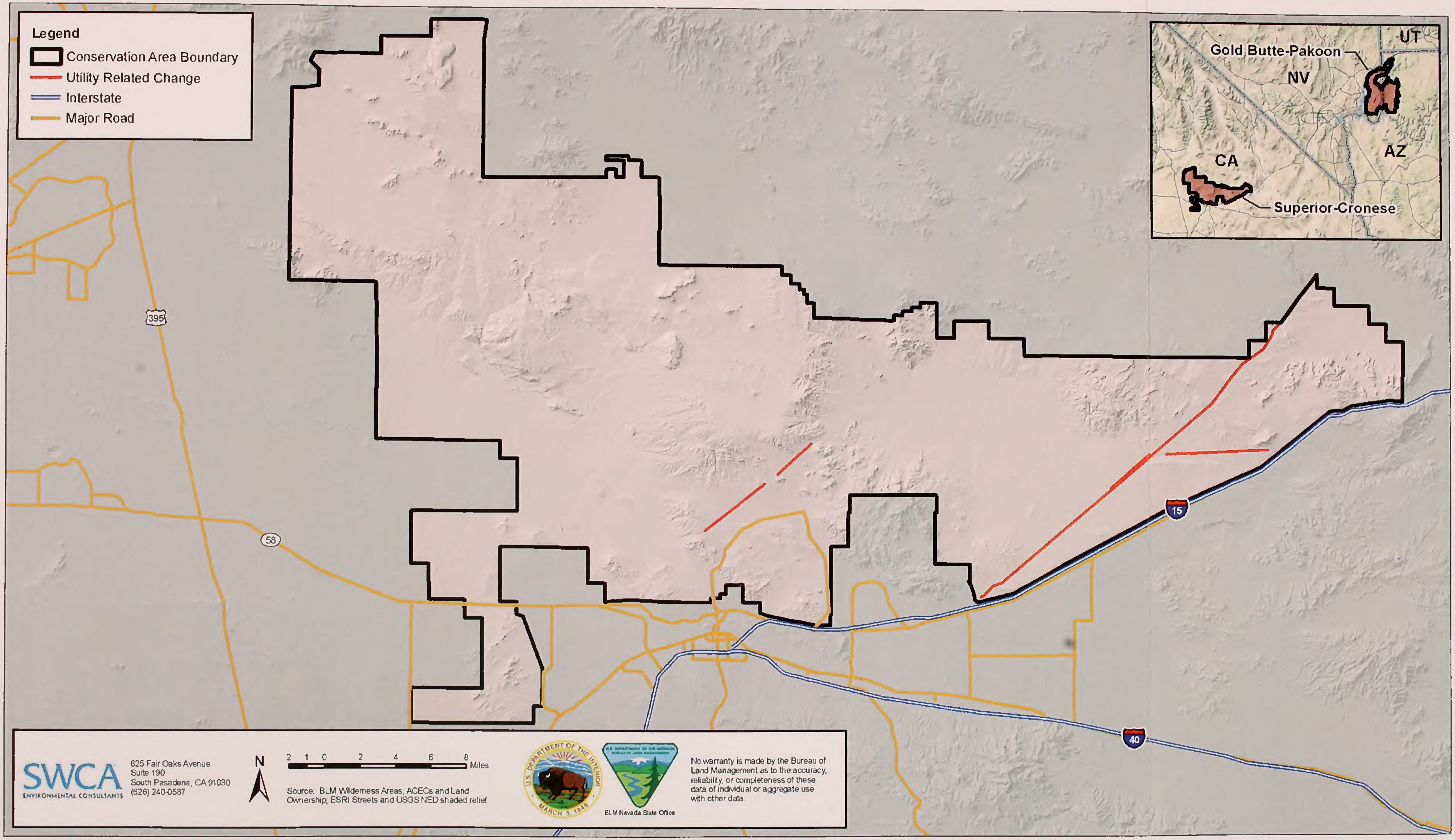

Figure E-16. Areas of change attributed to utility development within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.1.5 Landfills

Distribution/Severity of Threat within the Conservation Area

Two landfills account for approximately 94 acres within the Conservation Area. Additionally, a total of 0.5 miles of road accesses landfills exclusively within the Conservation Area, accounting for an additional 19.9 acres of effect (assuming a road effect of 50 meters from centerline of the road). Together these effects account for 113.9 acres or 0.00018% of the Conservation Area.

Distribution/severity variable (d) = 0.00018

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change within the Conservation Area attributed to landfill expansion (Figure E-17). The amount of change detected was 20 acres during the period between 1990 and 2001, and 46 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.00024

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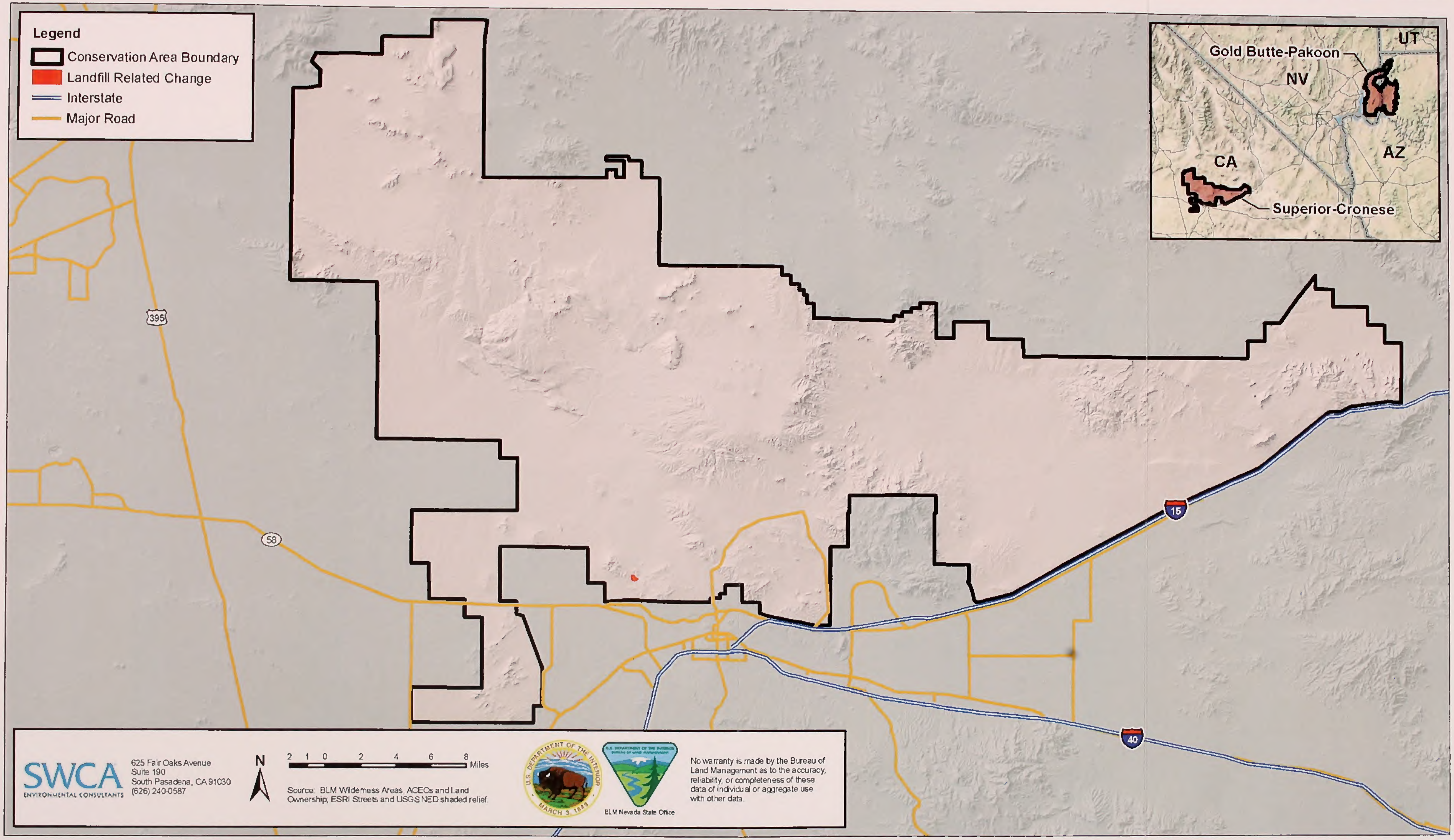

Figure E-17. Areas of change attributed to landfills within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.1.6 Anthropogenic Water Sources

Distribution/Severity of Threat within the Conservation Area

Anthropogenic water sources within the Conservation Area include two human-made ponds and one cooling pond associated with energy generation, accounting for 83 acres (0.00132% of the Conservation Area).

Distribution/severity variable (d) = 0.00132

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to anthropogenic water sources was not detected.

3.2 HUMAN ACTIONS AND ACTIVITIES

3.2.1 OHV Use

Distribution/Severity of Threat within the Conservation Area

A total of 1,790.7 linear miles of routes are currently designated within the Conservation Area. Assuming a road effect of 50 meters from centerline of the road, 71,212.12 acres (11.31% of the Conservation Area) are affected by OHV use.

Distribution/severity variable (d) = 11.31

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change attributed to OHV use within the Conservation Area (Figure E-18). The detected OHV use was confirmed through examination of Google Earth aerial photos. The amount of change attributed to OHV use within the Conservation Area was 4 acres during the period between 1990 and 2001, and 862 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.296

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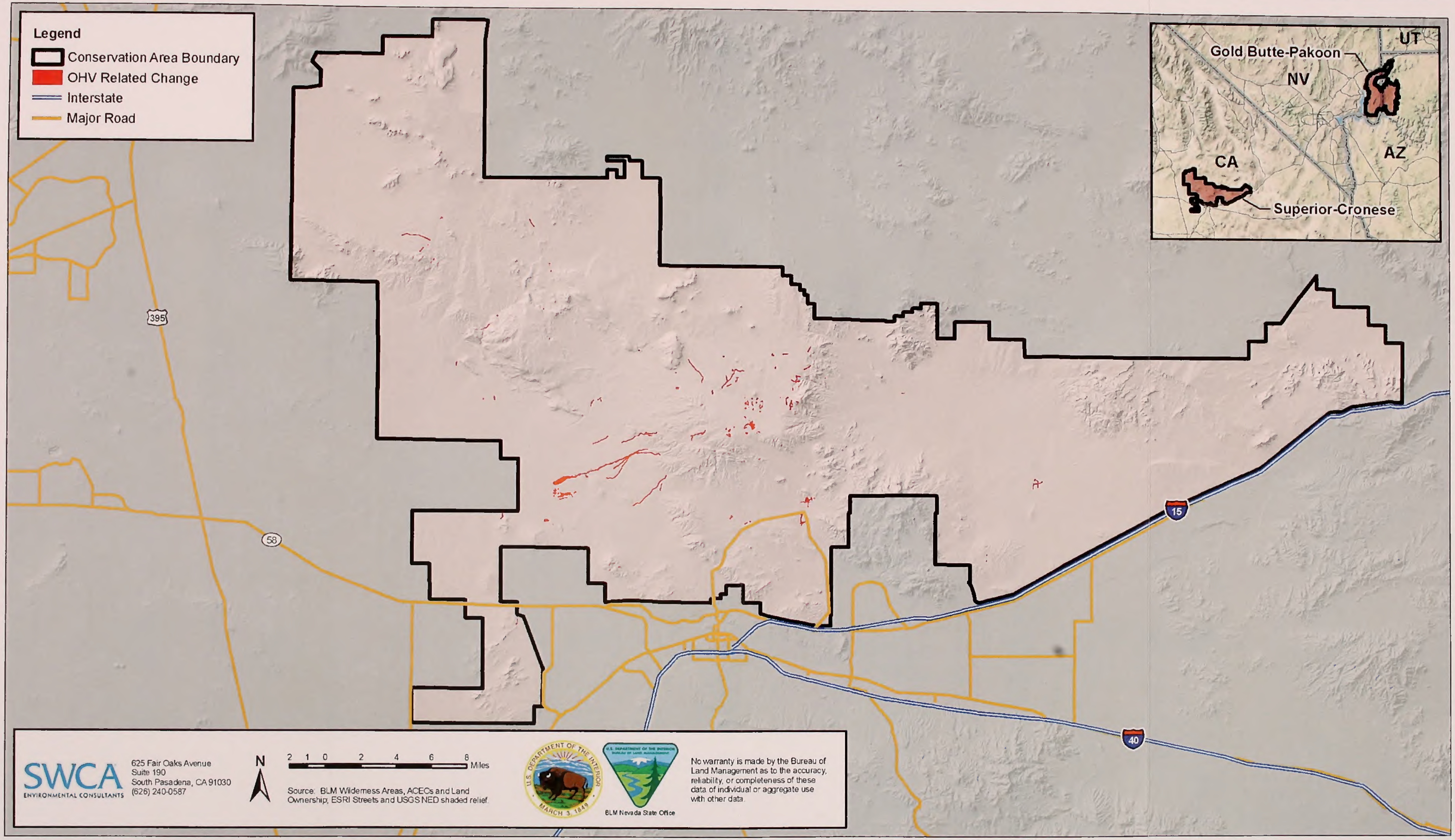

Figure E-18. Areas of change attributed to OHV use within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.2.2 Livestock Grazing

Distribution/Severity of Threat within the Conservation Area

Grazing allotments within the Superior-Cronese Conservation Area were closed in 2006 following implementation of mitigation measures required for permitting of the Fort Irwin Land Expansion project.

Distribution/severity variable (d) = 0.0

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change attributed to livestock grazing within the Conservation Area (Figure E-19). The amount of change attributed to livestock grazing within the Conservation Area was 0 acres during the period between 1990 and 2001, and 525 acres during the period between 2001 and 2006.

Degree of Change variable (C_t) = 0.438

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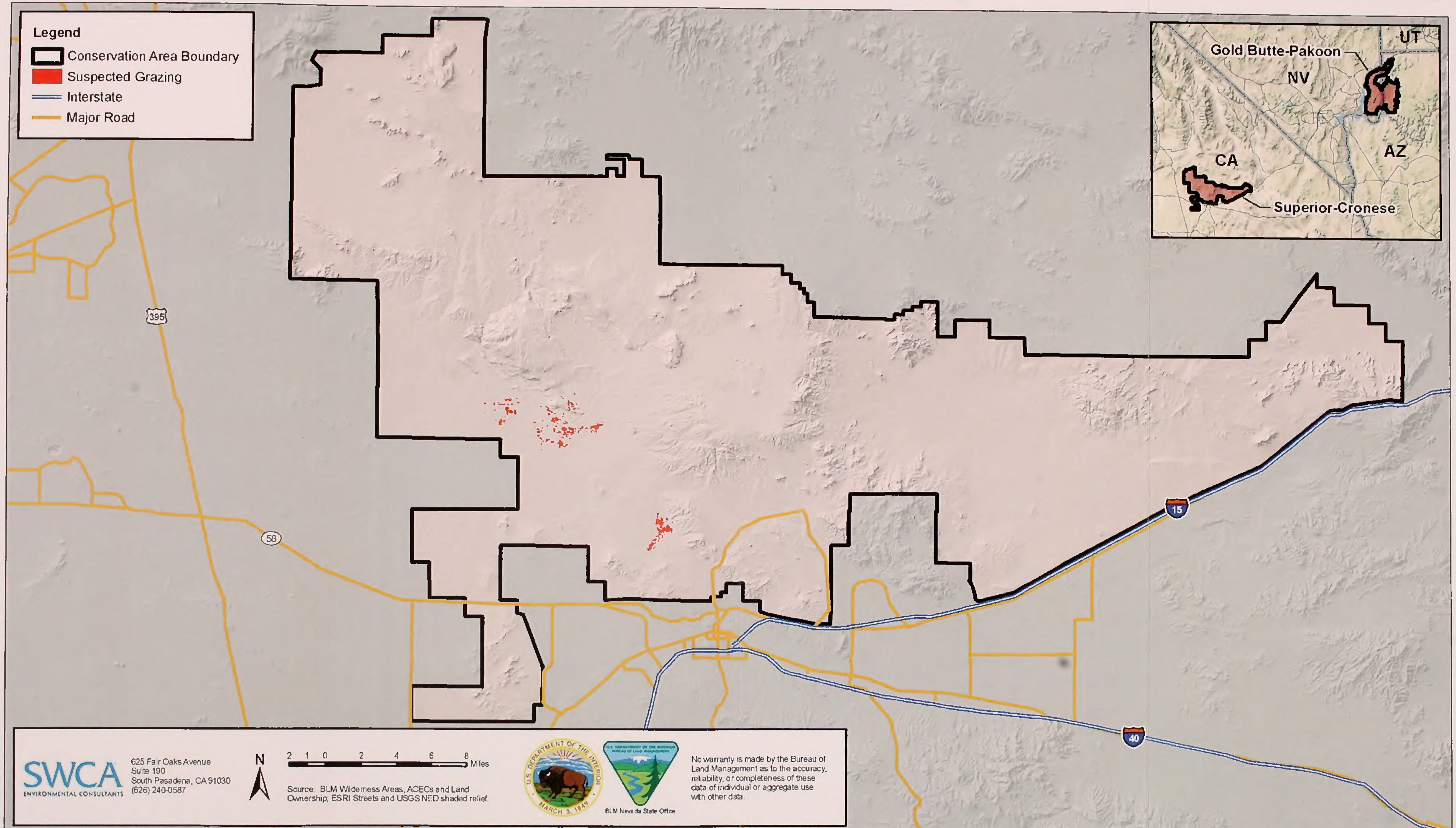

Figure E-19. Areas of change attributed to livestock grazing within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008, as determined using remote sensing techniques

3.2.3 Agricultural Practices

Distribution/Severity of Threat within the Conservation Area

Agricultural fields occur over 740 acres within the Conservation Area (0.118% of the Conservation Area).

Distribution/severity variable (d) = 0.118

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on developable topography (flat or bajada landforms) total 130,623 acres on private and state-owned in-holdings. Since 740 acres have already been converted to agricultural use, a maximum of 129,883 additional acres could be converted (20.63% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 20.63

Degree of Change of Threat

Change attributable to agricultural activities was not detected.

3.2.4 Mineral Extraction

Distribution/Severity of Threat within the Conservation Area

Mines and mineral extraction sites account for approximately 740 acres within the Conservation Area. Additionally, a total of 33.7 miles of roads/trails access mines exclusively within the Conservation Area, accounting for an additional 1,340.2 acres of effect (assuming a road effect of 50 meters from centerline of the road). Together these effects account for 0.33% of the Conservation Area.

Distribution/severity variable (d) = 0.33

Maximum Potential Occurrence of Threat on Land In-holdings

In-holdings within the Conservation Area that occur on topography conducive to mineral extraction (hill or mountain landforms) within parcels total 52,840.95 acres on private and state in-holdings (8.39% of the Conservation Area).

In-holding variable ($\hat{I}_{max}$) = 8.39

Degree of Change of Threat

Using remote sensing techniques, we identified areas of change within the Conservation Area attributed to mining and mineral extraction activities (Figure E-20). The amount of change detected was 2 acres during the period between 1990 and 2001, and 54 acres during the period between 2001 and 2008.

Degree of Change variable (C_t) = 0.0024

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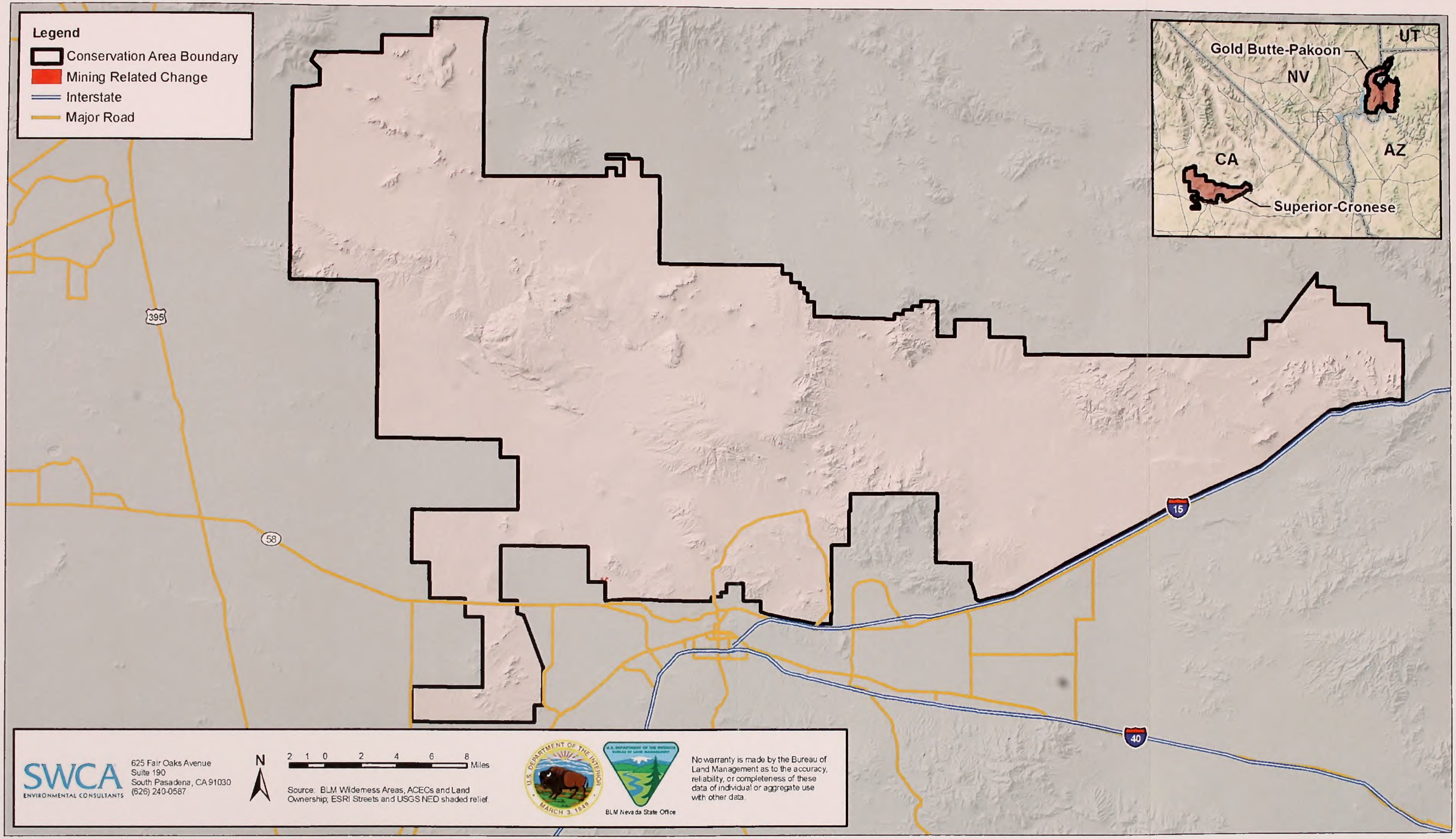

Figure E-20. Areas of change attributed to mining and mineral extraction activities within and adjacent to the Superior-Cronese Conservation Area between 1990 and 2008 as determined using remote sensing techniques

3.2.5 Military Activities

Distribution/Severity of Threat within the Conservation Area

Military activities within the Conservation Area include military equipment transfer along Manix Trail, the Cuddleback Lake Gunnery Range, and the Superior Valley Gunnery Range. The area of effect of Manix Trail was determined by assigning a buffer of 400 meters on each side of the road, resulting in an area of 4,784.2 acres. Area of effect of the gunnery ranges was determined by assigning a 50 meter buffer around these facilities, resulting in an area of 3,252.4 acres. Military activities occur over an area of 8,036.6 acres, or 1.28% of the Conservation Area.

Distribution/severity variable (d) = 1.28

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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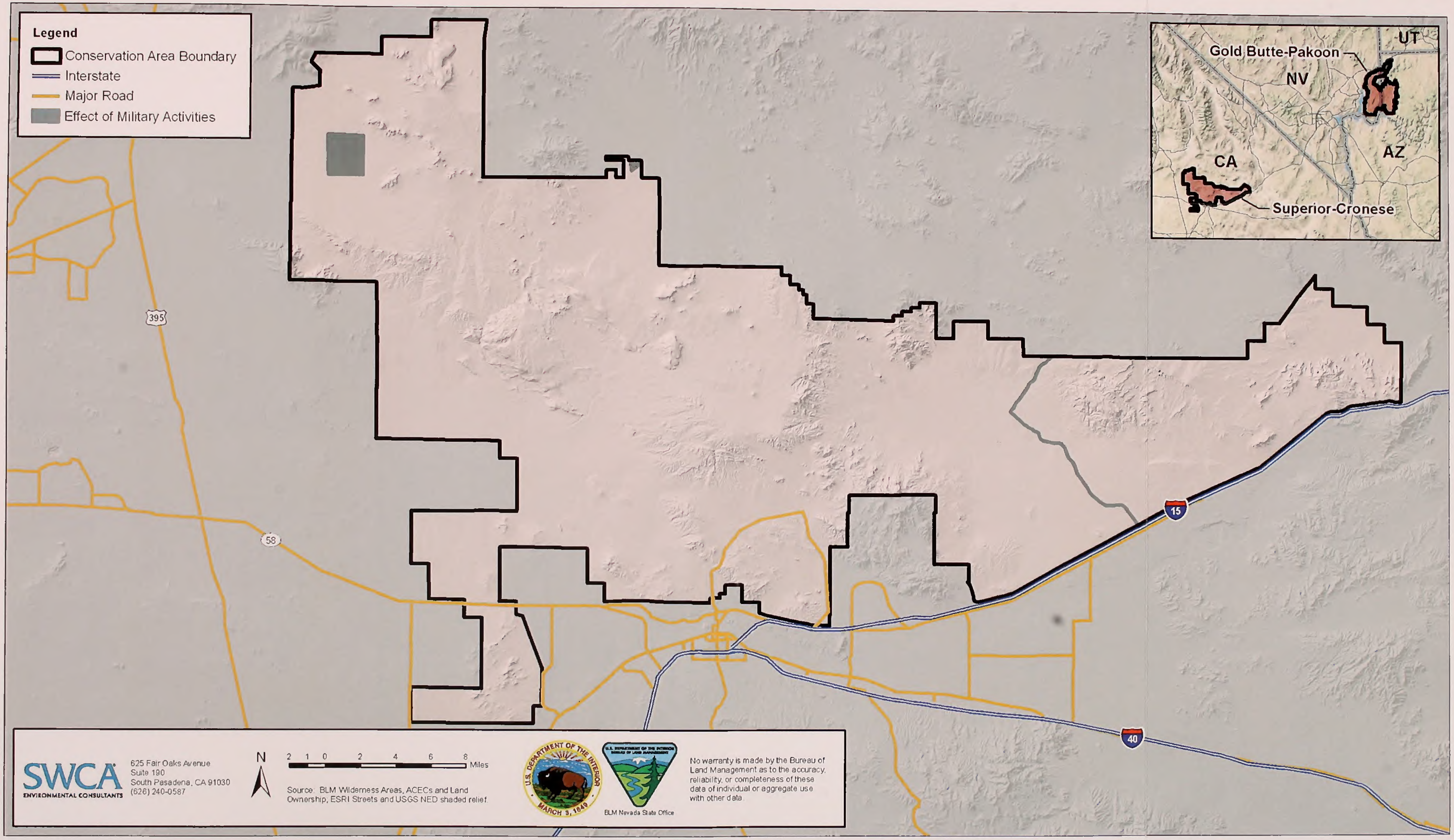

Figure E-21. Military activity areas within the Superior-Cronese Conservation Area

3.2.6 Litter and Illegal Dumping

Distribution/Severity of Threat within the Conservation Area

Because litter and illegal dumping occurs primarily in areas accessed by humans, the distribution of likely dump sites will be associated with human developments, including desert habitats adjacent to urbanized areas. In particular, roads and trails leading from urban areas into the Conservation Area are likely the sites of illegal dumping. We estimated the areas most subject to dumping activities along these roads and trails within a buffer area of urban developments. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3000 m for high density urban developments. Using this technique, we determined that 274.9 miles of roads and trails occur within the buffers, accounting for 10,932.16 acres (1.736% of the Conservation Area) of area of likely dump sites assuming a 50 m buffer from the centerline of the roads and trails leading from urbanized areas (Figure E-22).

Distribution/severity variable (d) = 1.736

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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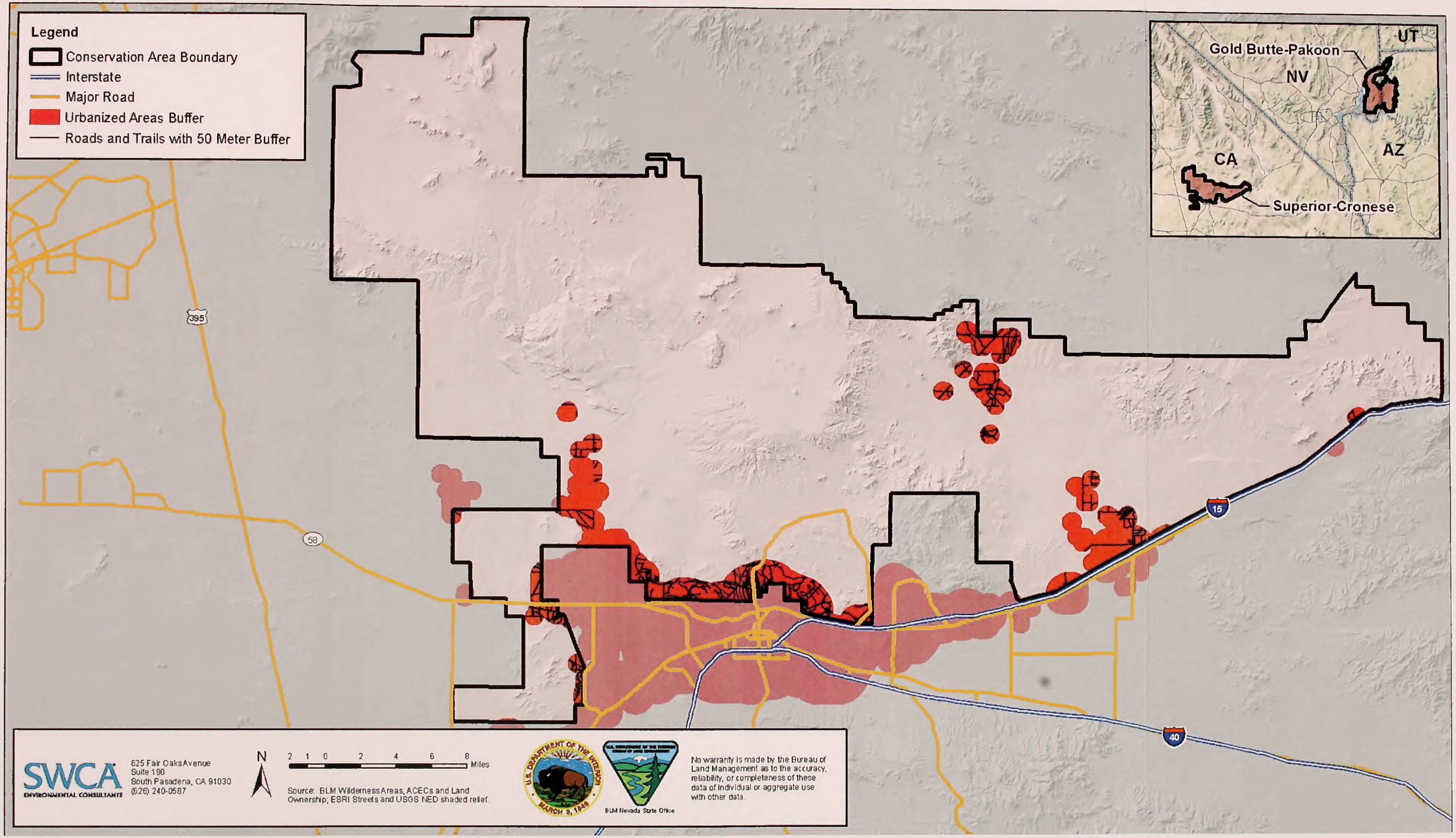

Figure E-22. Predicted areas of illegal dumping (along roads originating from urbanized areas) within the Superior-Cronese Conservation Area

3.2.7 Toxin and Pollutant Deposition

Distribution/Severity of Threat within the Conservation Area

Because deposition of toxins and pollutants occurs primarily in areas accessed by humans, the distribution of likely deposition sites and pollution sources will be associated with human developments and activity areas. Roads and trails leading from urban areas into the Conservation Areas are likely the sites of illegal dumping, which may contribute to toxin deposition. Other sites that likely introduce pollutants into desert environments include mines, landfills, and military activity areas. We determined the areas likely affected by toxin and pollutant deposition by placing a 50 m buffer around roads and trails leading from urbanized areas (as with litter and illegal dumping), as well as mines, landfills, and military activity areas. Using this technique, we determined that a total of 16,934.2 acres are the likely areas for toxin and pollutant deposition, including 10,932.2 acres along roads from urban areas; 2,022.3 acres around mines; and 3,979.7 acres around military use areas. In total, these account for 2.69% of the Conservation Area.

Distribution/severity variable (d) = 2.69

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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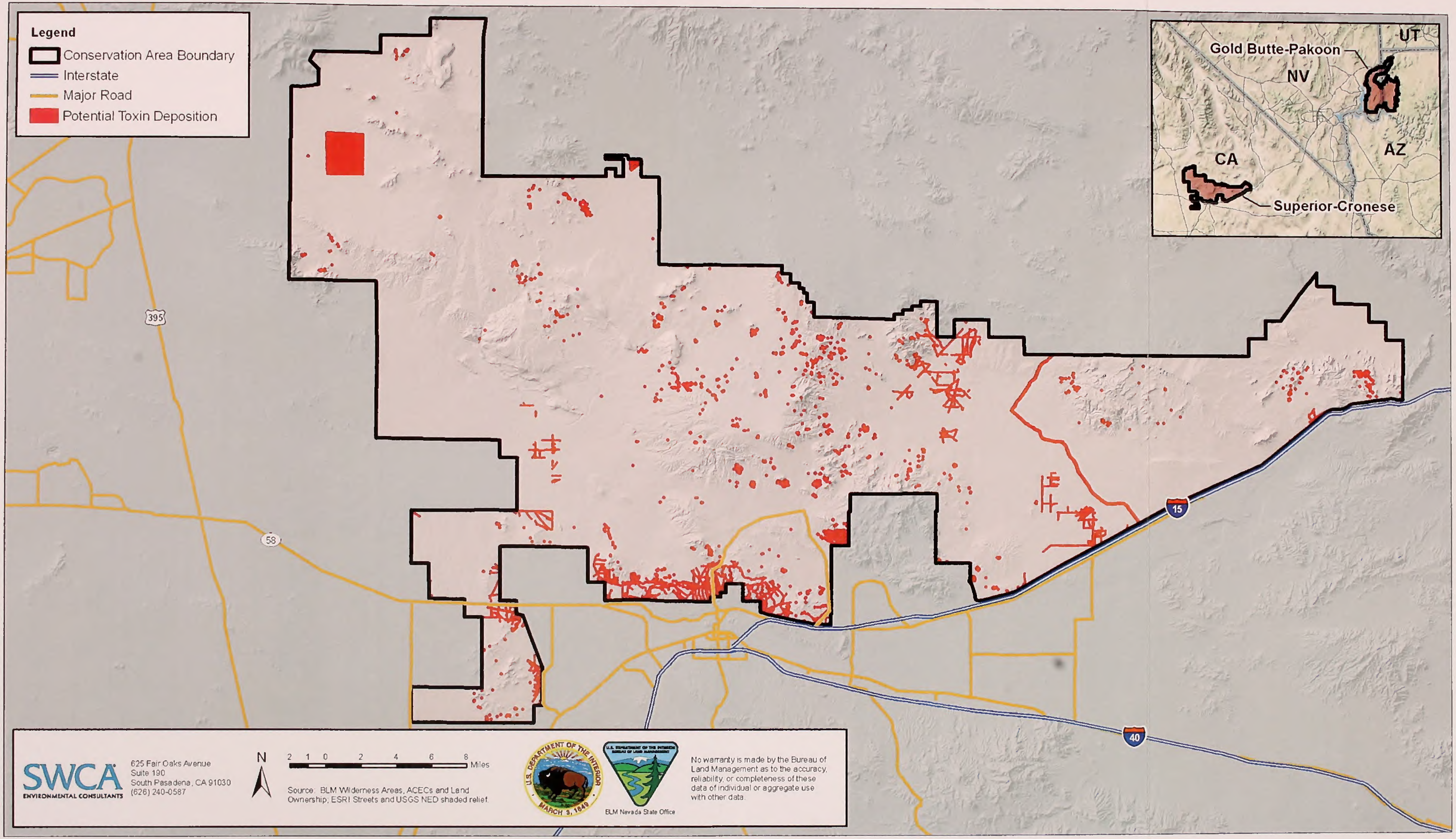

Figure E-23. Predicted areas of toxin and pollutant deposition within the Superior-Cronese Conservation Area

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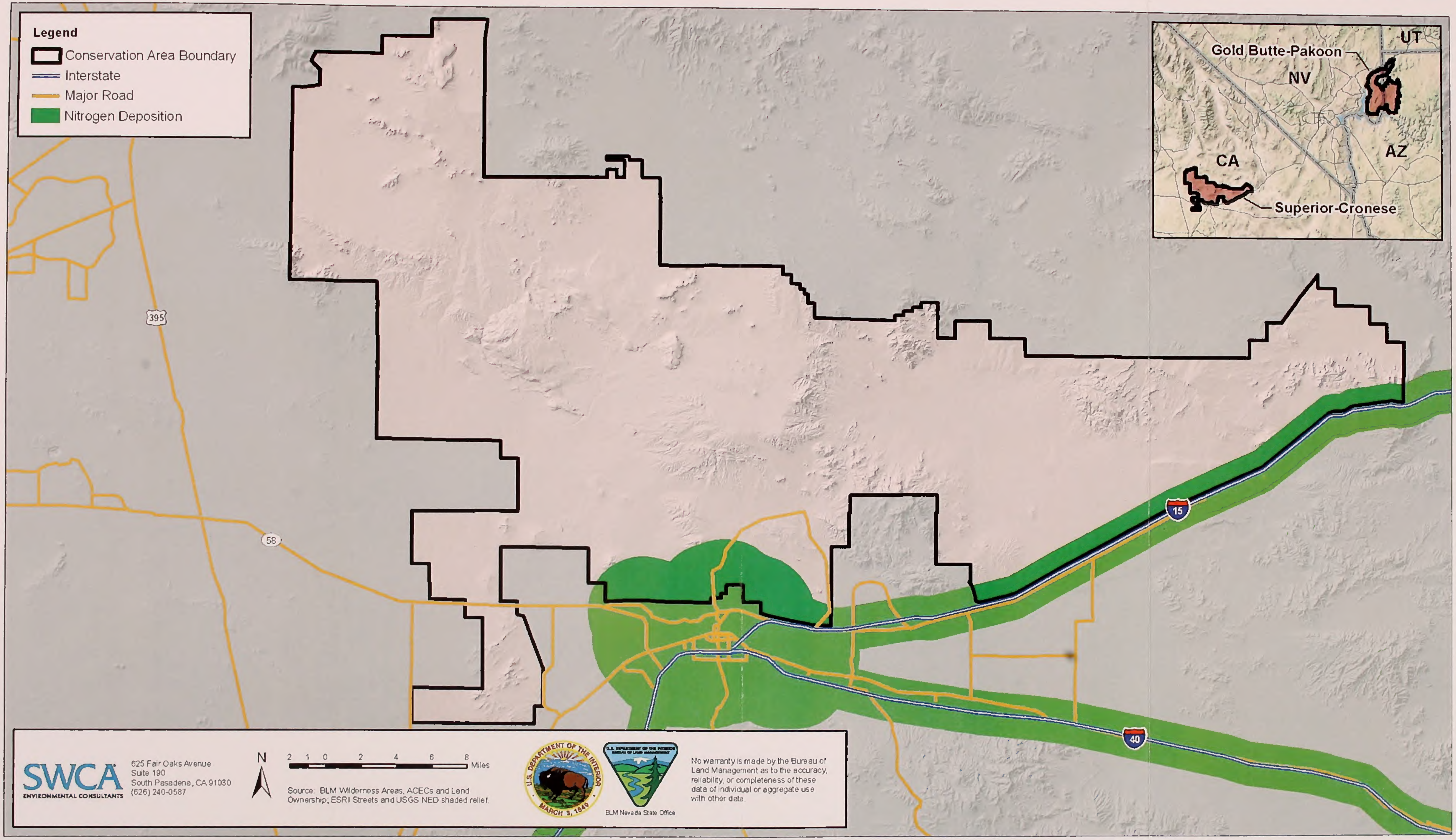

Figure E-24. Predicted area of high nitrogen deposition within the Superior-Cronese Conservation Area

3.2.9 Climate Change

Distribution/Severity of Threat within the Conservation Area

Climate change may affect desert environments within the Conservation Area by increasing the frequencies of wildfire and drought, as well as change the elevation limits of vegetation communities that define desert tortoise habitat. We examined the effect of raising the preferred elevation limits of desert tortoise (lower and upper) by 318 m, a figure predicted as a consequence of a rise in mean global temperatures by 2°C by the year 2050 (Bare et al 2009). We modeled the predicted change in elevation of desert tortoise habitat, and determined that there would be no areas excluded from the current habitat model.

Tortoise Distribution: Distribution/severity variable (d) = 0

We also examined the effects of climate change on increased frequencies of wildfire and drought. For each, we estimated frequencies of an additional 20% over frequencies observed between 1990 and 2008.

Wildfire: Distribution/severity variable (d) = 20.061

Drought: Distribution/severity variable (d) = 52.25

Mean (d) = 36.16

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

3.2.10 Collection and Poaching by Humans

Distribution/Severity of Threat within the Conservation Area

Because collection and poaching of desert tortoises by humans occurs primarily in areas accessed by humans, the distribution of likely tortoise collection areas will be associated with human developments and activity areas, including urbanized areas and OHV routes, as well as adjacent desert habitats in the vicinity of these developments and activity areas. We estimated the areas most vulnerable to tortoise collection and poaching activities along roads within the Conservation Area by determining the linear miles of routes within modeled desert tortoise habitat, and determining acreages along these routes by providing a 50 m buffer on the centerline of these roads. Using this technique, we determined that 2,255.2 miles of roads and trails occur within modeled desert tortoise habitat, accounting for 89,684.2 acres of area assuming a 50 m buffer from the centerline of the road. We further estimated the effect of urbanized areas on collection and poaching of tortoises by humans by determining acreage of desert tortoise habitat within a buffer of urban developments. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3000 m for high density urban developments. We calculated the acreage within these buffers to be 42,292 acres within the Conservation Area. Therefore, the predicted area of vulnerability to collection and poaching of tortoises by humans occurs over 131,976.2 acres (20.96% of the Conservation Area).

Distribution/severity variable (d) = 20.96

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

3.2.11 Translocation of Populations

Distribution/Severity of Threat within the Conservation Area

Desert tortoises translocated from the Southern Expansion Area at Ft. Irwin were released onto numerous plots within the Superior-Cronese Conservation Area. Many of the released tortoises dispersed from these plots to distances of up to 5km from their release locations (D. Hinderle, personal communication). Considering a 5km buffer around each of the release plots, we determined the total area of affect to be 183,644.7 acres or 29.2% of the Conservation Area (Figure E-25).

Distribution/severity variable (d) = 29.2

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

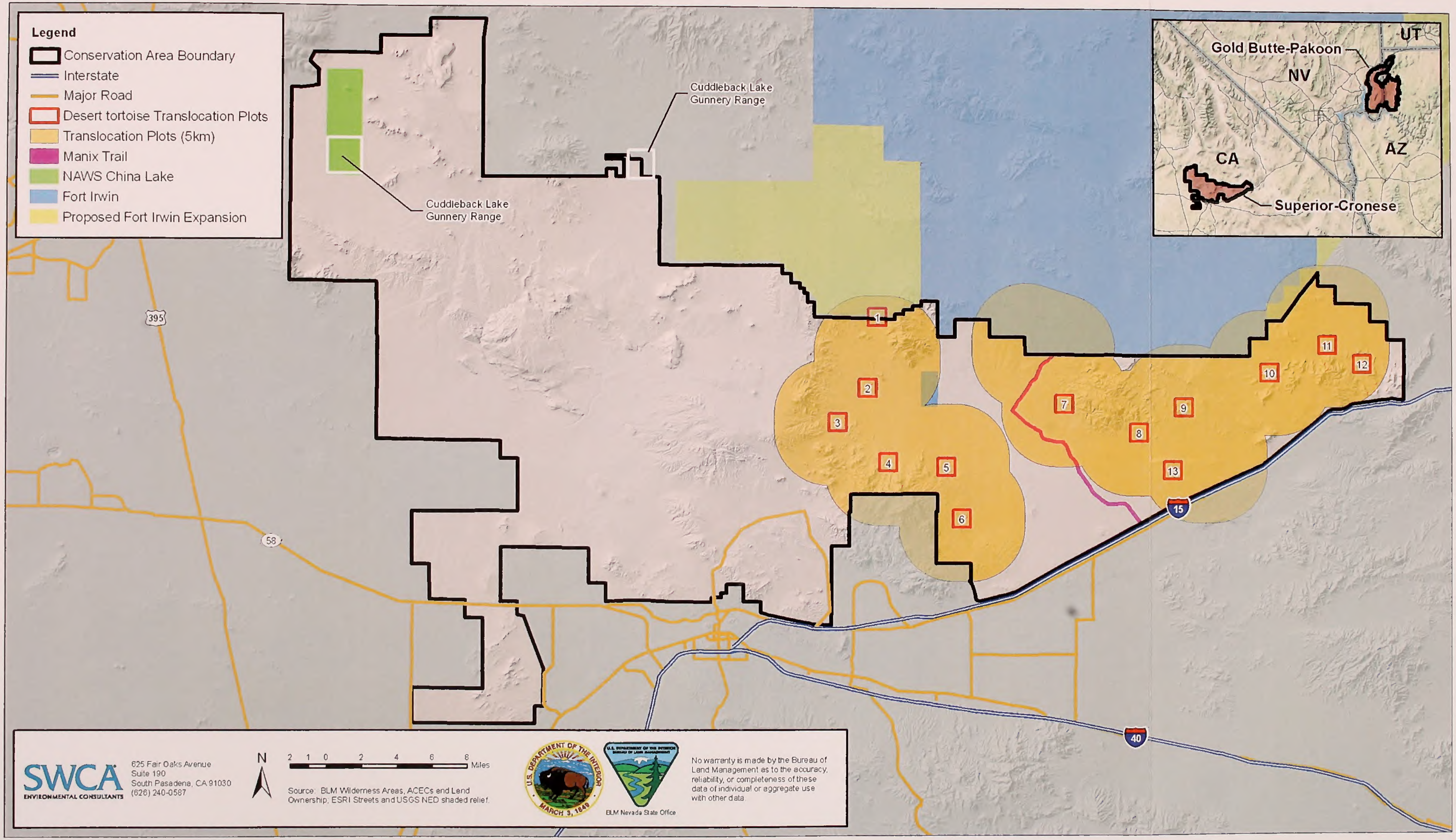

Figure E-25. Area affected by the translocation of desert tortoises from the Southern Expansion Area of Ft. Irwin, as determined by estimating dispersal distances of translocated tortoises

3.3 Environmental/Biological Factors

3.3.1 Drought

Distribution/Severity of Threat within the Conservation Area

During the period under study (1990 through 2008), there was one annual winter precipitation accumulation that was less than 25 mm (2007) and nine annual summer accumulations that were less than 25 mm, including two periods (1992-1996 and 2001-2003) when low accumulations resulted in multi-year droughts, and an additional accumulation below 25 mm in 2007. Accordingly, we estimate the probability of accumulations of less than 25 mm to be 5.26% for winter seasons and 47.37% for summer seasons. Additionally, two droughts occurred during the period of study that lasted four and three years each. We therefore estimate the probability of summer droughts lasting an average of four years to be 44.11% over roughly a 20 year period.

Winter season accumulations <25 mm: Distribution/severity variable (d) = 5.26

Summer season accumulations <25 mm: Distribution/severity variable (d) = 47.37

Summer season drought: Distribution/severity variable (d) = 44.11

Mean (d) = 32.25

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

3.3.2 Fire

Distribution/Severity of Threat within the Conservation Area

Fire has affected small portions of the Conservation Area. Wildfires have been mapped over 384.2 acres (0.061% of Conservation Area) between 1990 and 2008.

Distribution/severity variable (d) = 0.061

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

Change attributable to fire was not detected.

3.3.3 Disease

Distribution/Severity of Threat within the Conservation Area

The threat of disease is within and in the vicinity of the Conservation Area appears to be associated with urban developments, office buildings, paved roads, and military use areas (Berry et al. 2006; Mack and Berry 2009). Since studies in other portions of the range of the desert tortoise indicate that tortoise populations in proximity to urban areas suffer from higher rates of URTD incidence, we estimated the

probability of occurrence within the Conservation Area by placing a buffer around urban areas. The buffers consisted of 750 m for single-family ranch developments, 1500 m for low density developments, and 3,000 m for high density urban developments. Additionally, we placed a 400 m buffer around paved roads, a 750 m buffer around the military gunnery ranges, and a 400 m buffer around Manix Trail. Using this technique we estimated the acreage within these buffers to be 77,155.2 acres within the Conservation Area (12.25% of the Conservation Area).

Distribution/severity variable (d) = 12.25

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

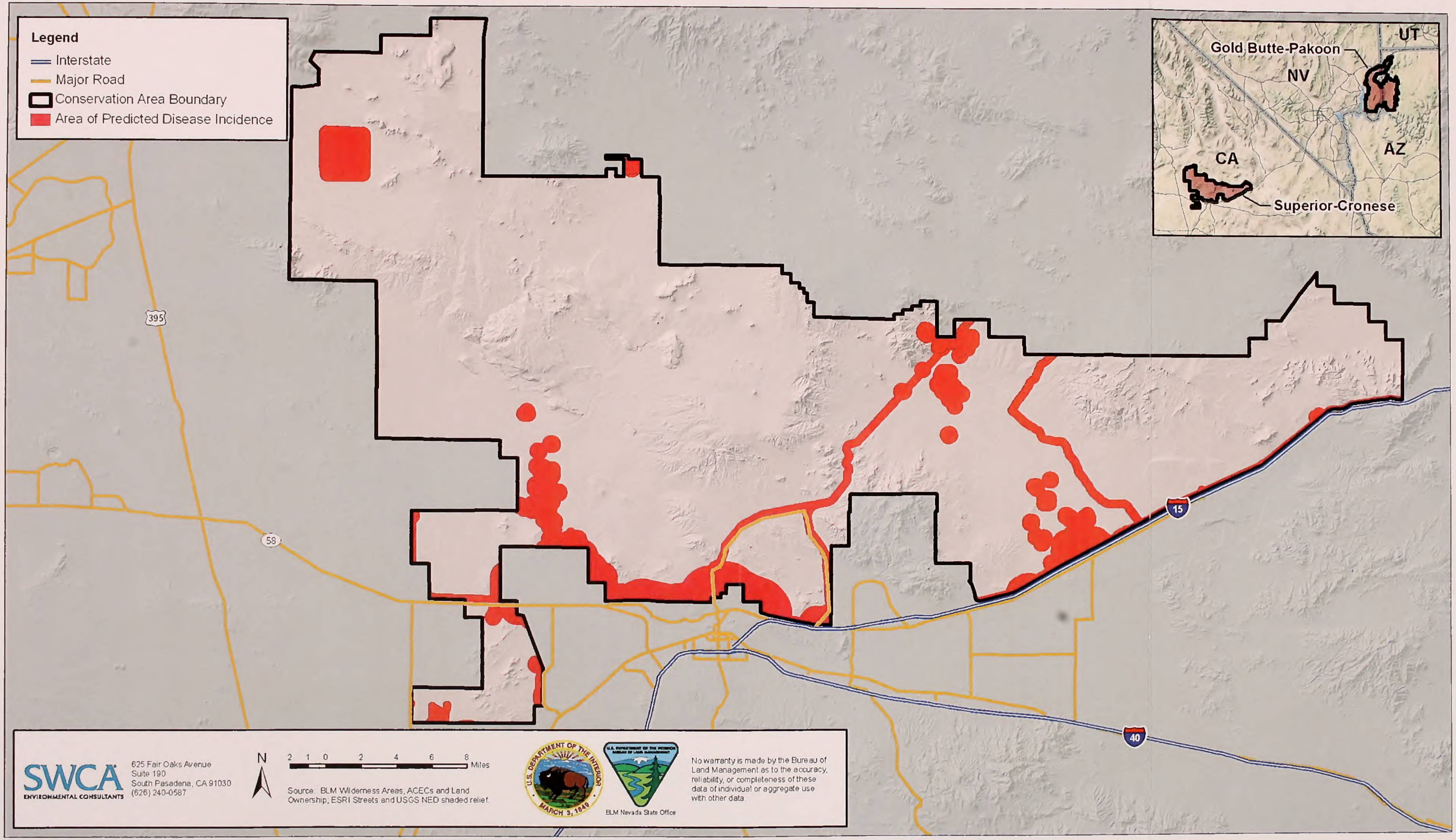

Figure E-26. Predicted area of increased probability of disease incidence within the Superior-Cronese Conservation Area

3.3.4 Subsidized Predators

Distribution/Severity of Threat within the Conservation Area

We estimated the probability for occurrence of subsidized predators by placing a buffer around features that provide subsidies for ravens, coyotes, and other subsidized predators. Based upon information provided in Boarman and Kristan (2006), we included a buffer of 4.46 kilometers from urbanized areas, landfills, open sources of anthropogenic water, major highways, and agricultural fields. Additionally, following Boarman (2002), we placed a buffer of 400 m around transmission lines that provide nesting structures for breeding ravens. Using this technique, we predicted an area of 257,371 acres (25.32% of the Conservation Area) that would support higher densities of predators based upon human subsidies (Figure E-27).

Distribution/severity variable (d) = 40.82

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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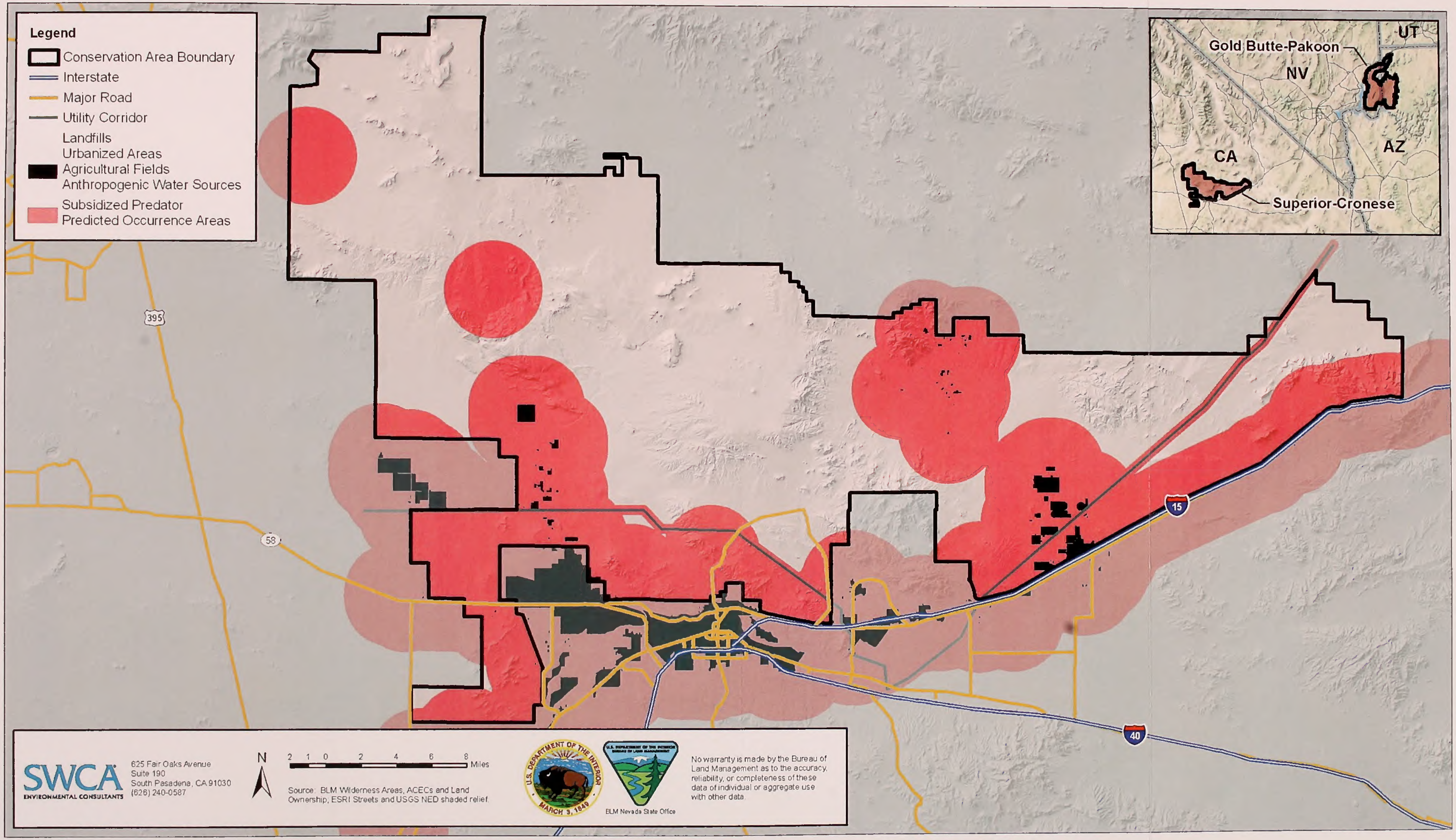

Figure E-27. Predicted occurrence area for predator populations subsidized by anthropogenic food and water sources

3.3.5 Invasive Plants

Distribution/Severity of Threat within the Conservation Area

Invasive plants are likely present throughout the entire Conservation Area, though abundances may be differentially distributed, i.e, invasive species biomass is greater in areas affected by soil disturbances and nitrogen deposition. Without detailed data we assume that the entire Conservation Area is affected by invasive plants (100.0% of the Conservation Area).

Distribution/severity variable (d) = 100.00

Maximum Potential Occurrence of Threat on Land In-holdings

N/A

Degree of Change of Threat

N/A

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Appendix B
Development of the Habitat Model

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Development of the Habitat Model

Michael Tuma and Paul Burnett

1. INTRODUCTION

We developed a habitat model to describe relative quality of desert tortoise habitat within the Superior-Cronese plan area. This model would allow BLM land managers to prioritize areas of relatively high quality habitat when managing for desert tortoise conservation. We chose to model habitat using a predictive occurrence model, which uses stepwise logistic regression techniques in comparing known presence and absence locations for desert tortoises to the known presence and absence of their habitat elements. The model returns an estimate of probability for desert tortoise occurrence within the plan area based upon the distribution of a variety of habitat elements. We chose and mapped habitat elements that are known to be important for desert tortoises. The USGS previously developed a predictive occurrence model for desert tortoises using this technique (Nussear et al. 2009). This model was developed across the entire range of the species at a larger scale than we considered in the development of our model. The development of the predictive model at smaller scale allows for high resolution at the landscape scale.

We developed the predictive occurrence model using a raster data structure, which divided the plan area into a grid of cells, each containing binomial data (presence=1; absence=0). We chose a 30 m cell size, which provided high resolution for assessing habitat elements and presence/absence data for tortoises within the study area. We clipped a total of 4,242,964 cells to the study area using this resolution, assessed the data layers for proper cell alignment, and converted them to the same projection and datum for use in the model (WGS 1984 Web Mercator Auxiliary SPhere). The data were treated and analyzed in several steps as detailed below.

We compared presence and absence of desert tortoises with the presence or absence of the modeled habitat elements within each grid cell. We used stepwise logistic regression to determine relationships between tortoise presence and absence and certain habitat elements. Stepwise logistic regression is one of the best and most widely used approaches for probabilistic modeling (Aldrich and Nelson 1984; Hosmer and Lemeshow 2000; Peduzzi et al. 1980; Stopher and Meyburg 1979). This method produces a prediction equation for desert tortoise occurrence with probabilities ranging from low (0) to high (1). While not free from problems, this type of statistical analysis was chosen for several reasons. First, it is capable of incorporating many types of data, including parametric or nonparametric; categorical or nominal; and continuous or ratio-scale data. Second, stepwise logistic regression is designed to accept a large number of independent variables (i.e., environmental datasets) and eliminate those that either are redundant or do not correlate significantly with the dependent variable (i.e., tortoise occurrence). Third, the method applies unique weights to the independent variables in the optimal equation that determines the probability of tortoise occurrence, and the values in this equation can be replicated in a GIS environment. Previous criticisms of stepwise logistic regression were primarily concerned with the fact that the model results could not be tested using conventional statistical significance criteria, as all of the occurrence data were used to build these earlier models, and thus could not be used to test them. However, this problem is overcome by building the model with half of the dataset while testing it with the other half (Kvamme 1988; Warren 1990).

2. TORTOISE PRESENCE/ABSENCE DATA

We determined tortoise presence within each 30 m grid cell from census surveys of study plots, radio telemetric observations, opportunistic field observations, and previously collected occurrence data. Since each grid cell was scored as either a "1" for presence or a "0" for absence, tortoise presence within a cell was independent of the number of observations within the cell. For example, a cell was assigned a score

of '1' whether it contained one tortoise observation or 20. We initially determined the number of presence cells within the plan area in order to determine how many absence cells would be required for the training and testing samples. Absence cells were selected at a 2:1 ratio to presence cells to avoid saturating the model with absence data. Absence data were determined from census surveys of study plots, supplemented with absence data from habitats in the plan area that were not surveyed but are known to not contain desert tortoise habitat, such as mountainous or riparian habitats. The presence and absence cells were each randomly assigned to either the model training or model testing datasets. To reduce spatial autocorrelation, adjoining presence cells were included in the same training or testing dataset.

3. HABITAT ELEMENTS

Habitat elements used in the model development were chosen based on expert opinion of desert tortoise habitat preferences and a thorough review of literature pertaining to desert tortoise habitat. The habitat element dataset included precipitation data, topographic data, biotic data, and geomorphologic data. Specifically:

- Average annual rainfall
- Winter precipitation (November through February)
- Summer precipitation (June through September)
- Vegetation communities
- Elevation
- Aspect
- Slope
- Surface roughness
- Soil parent material
- Soil pedogenic setting
- Soil caliche potential
- Geology

3.1 Average Annual Rainfall

Since water availability is the greatest constraint to tortoises in the Mojave Desert, we included average annual rainfall in the habitat model to determine whether tortoise presence in a habitat was affected by average annual water availability. We compiled precipitation data from the Oregon State University's Parameter-elevation Regressions on Independent Slopes Model (PRISM) Group. We averaged annual precipitation accumulations for each grid within the study area from 1990 through 2010. The dataset is somewhat coarse (2.5 arc-minute, or ~4 km) for the Mojave Desert region, but variability for these phenomena is minimal from a macro perspective. We estimated spatial resolution at one-half, or roughly 2 km. We modeled average precipitation accumulations as continuous variables.

3.2 Winter Precipitation

We modeled winter precipitation (November through February) to assess annual biomass production/tortoise foraging habitat potential. We obtained precipitation data from PRISM, and modeled average precipitation accumulations as continuous variables.

3.3 Summer Precipitation

We modeled summer precipitation (June through September) to assess the influence of this habitat element in providing drinking and summer foraging opportunities for tortoises. We obtained precipitation data from PRISM, and modeled average precipitation accumulations as continuous variables.

3.4 Vegetation

We mapped vegetation communities within the plan area using GAP data. We simplified the 32 vegetation communities that were mapped within the study area into 14 categories (Table B-1).

3.5 Elevation

Elevation appears to be an important constraining element for desert tortoise occurrence. We mapped elevation by accessing the USGS National Elevation Dataset, and modeled elevation as a continuous variable.

3.6 Aspect, Slope, and Surface Roughness

Geomorphological features in the landscape, including aspect, slope, and surface roughness, have a profound effect on the distribution of desert tortoises; thus, considering geomorphological data is critical in assessing habitat potential for this species. These geomorphological features have consequences for exposure to sunlight, precipitation, and wind, which affects the distribution of soils and vegetation. Geomorphological features may also influence shade and shelter resources for desert tortoises. Finally, washlets on hillsides, flat boulder exposures, and other areas where water accumulates provide important drinking features during rain events and are important microhabitat characteristics. We obtained geomorphological data from the USGS National Elevation Dataset Digital Elevation Model (DEM). We modeled slope and surface roughness as continuous variables, and aspect as a categorical variable (north, northeast, east, etc.). During statistical analysis, surface roughness was excluded from the presence and absence cells due to a lack of variability in the samples.

3.7 Soils

Soils are a critical element of desert tortoise habitat, primarily because the species exhibits burrowing behaviors, is semi-fossorial, and depends on subterranean shelter sites. Caliche development in calcareous soils ranges from weak consolidation of sediments within a poorly-developed precipitate matrix to indurated hardpan in well-developed precipitate. Well-formed burrows may be excavated in weakly to moderately-consolidated caliche precipitate, whereas caves are excavated by tortoises (and many other desert wildlife) below exposed layers of indurated hardpan in wash banks and on hillside escarpments. Parent material affects caliche deposition in two distinct ways. First, soils that formed on calcareous parent material accumulate caliche at a greater rate than those that formed on non-calcareous parent material. Second, parent material affects the water-holding capacity of soils, which ultimately determines the depth of wetting and calcium carbonate deposition. Wind is critical in the formation of caliche in non-calcareous desert soils (particularly those in the eastern Mojave Desert), where windborne dusts and dissolved constituents in precipitation are thought to be the dominant sources of calcium for calcium carbonate deposition (Marion et al. 1985; Schlesinger 1984). We mapped soils within the Conservation Areas by accessing the Soil Survey Geographic (SSURGO) Database maintained by the Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA) (http://soils.usda.gov/survey/geography/ssurgo). We simplified 131 soil types or associations that were mapped within the study area into 37 categories among three types of soil attribute classes (Table B-1).

3.8 Geology

Geology likely plays an important role in the development of soils suitable for burrow construction and caliche cave occupancy. In particular, calcium that is leached from limestone and other calcareous sedimentary rocks provides the parent source for calcium carbonate precipitate in caliche layers. As well, metamorphic rocks, such as granite and gneiss, provide parent material for loamy soils. We mapped surface geology from the digitized Geologic Map of California (Saucedo et al. 2000). We used the 17 geology designations that were mapped within the study area (Table B-1).

Table B-1. Attribute classes for environmental variables pertaining to vegetation communities, soil, and geology.

Category	Attributes (n=# of types included in this attribute)
Vegetation Communities	Badland/outcrop (n=3) Desert Pavement (n=1) Desert scrub (n=3) Desert wash (n=1) Disturbed (n=6) Dunes (n=1) Greasewood flat (n=1) Juniper woodland (n=2) Riparian woodland (n=2) Sagebrush scrub (n=1) Wetland (n=2)
Soil Pedogenesis	Alluvial sediments (n=8) Alluvial and eolian sediments (n=2) Colluvial sediments (n=1) Residual and colluvial sediments (n=2)
Soil Parent Material	Mixed sources (n=11) Quartzite, schist, and gneiss (n=1) Volcanic rock (n=1)
$CaC0_3$ Development in Soil Horizon	None (n=9) Weak (n=3) Strong (n=1)
Geology	Alluvium/terrace Argillite /chert Basalt/tephrite Conglomerate Dune sand/lake or marine deposit Gabbro/diorite Gneiss/granitoid Granodiorite/quartz monzonite Greenstone/andesite Intermediate volcanic rock/mafic volcanic rock Marble/limestone Plutonic rock/gneiss Rhyolite/basalt Rhyolite/dacite Sandstone/conglomerate Schist/gneiss Water Body

4. STATISTICAL DEVELOPMENT AND TESTING OF THE MODEL

Once the rasters for each of the mapped environmental variables were created, the occurrence of each category within each cell was tabulated in a matrix for statistical analysis. Accordingly, a matrix was generated for each cell, which contained presence (1) and absence (0) of each environmental category. We used the JMP 10 statistical package to apply the stepwise logistic regression and develop the probability equations for tortoise presence and absence against these variables. These variables were applied to the grid dataset (in a GIS) to generate tortoise occurrence probability (ranging from 0 to 1) within each cell. We then converted this probability raster into a shape file depicting ten categories of probability (0-0.10, 0.10-0.20, etc.), and tested the accuracy of the spatial probability distribution and

model efficiency. We used the second set of tortoise presence/absence data to test the accuracy of model predictions produced from the models developed with the training and test samples.

Following Kvamme (1988:329), we employed the gain statistic for the model training and testing samples. This allowed us to gauge the efficiency of the model by comparing the area where tortoises are predicted to occur with the actual number of tortoises in the predicted occurrence areas using the following equation:

Gain = 1 – (% of area predicted to support tortoise occurrence / % occurrences within the predicted occurrence area)

5. MODELING RESULTS

The analysis revealed that the both the training model and the testing model correctly predicted over 85 percent of the opposite sample (Table B-2).

Table B-2. Correct and incorrect predictions per sample (training and testing models). The number of 30-m cells in each category is listed. "Occurrences" are known desert tortoise locations.

Sample	True Positive	False Positive	True Negative	False Negative	Total Occurrences	Total Non-occurrences	%True Positive	%True Negative	%Total Correct Predictions
1 (Training)	358	65	911	131	489	976	73.2	93.3	86.6
2 (Test)	376	76	903	114	490	979	76.7	92.2	87.1

Results of the gain analysis revealed that the model developed with the training data was slightly more efficient than the test model (Table B-3). The model, presented in Figure B-1, depicts areas of probability for occurrence of desert tortoises based upon the distribution of habitat elements within the plan area.

Table B-3. Gain data associated with the range of probability models.

Minimum Probability	Acreage	Acreage Percent	Number of Occurrences	Percent of Occurrences	Gain
Training Samples					
0	943613.3	100.0	944	100.0	0.000
0.1	827545.0	87.7	900	95.3	0.080
0.2	763344.3	80.9	852	90.3	0.104
0.3	708965.2	75.1	809	85.7	0.123
0.4	659788.1	69.9	759	80.4	0.130
0.5	608148.7	64.4	707	74.9	0.139
0.6	562266.9	59.6	650	68.9	0.135
0.7	516769.6	54.8	588	62.3	0.121
0.8	466884.2	49.5	517	54.8	0.097

Minimum Probability	Acreage	Acreage Percent	Number of Occurrences	Percent of Occurrences	Gain
0.9	406456.4	43.1	424	44.9	0.041
Test Samples					
0	943613.3	100.0	944	100.0	0.000
0.1	823597.7	87.3	910	96.4	0.095
0.2	763252.9	80.9	862	91.3	0.114
0.3	719937.0	76.3	814	86.2	0.115
0.4	676852.3	71.7	770	81.6	0.121
0.5	639224.6	67.7	737	78.1	0.132
0.6	588244.6	62.3	678	71.8	0.132
0.7	528294.5	56.0	604	64.0	0.125
0.8	467649.0	49.6	478	50.6	0.021
0.9	398195.5	42.2	381	40.4	-0.046

The environmental variables retained by the stepwise logistic regression (using a Minimum AICc [Akaike Information Criteria] cutoff), and therefore the habitat elements that best explained the occurrence of desert tortoises within the Superior-Cronese plan area, were:

- Annual Precipitation
- Summer Precipitation
- Winter Precipitation
- Aspect
- Parent Material
- Geology
- Pedogenic Setting
- Vegetation Community
- Caliche Potential

From west to east, the habitat model depicted areas of high probability for desert tortoise occurrence in the Grass Valley/Gravel Hills area, the Mud Hills/Calico Mountains and surrounding areas north of Barstow, portions of the Paradise Range, predominantly south-trending slopes north of Coyote Lake, and Alvord Mountain and areas to the east toward the Cronese Mountains (Figure B-1).

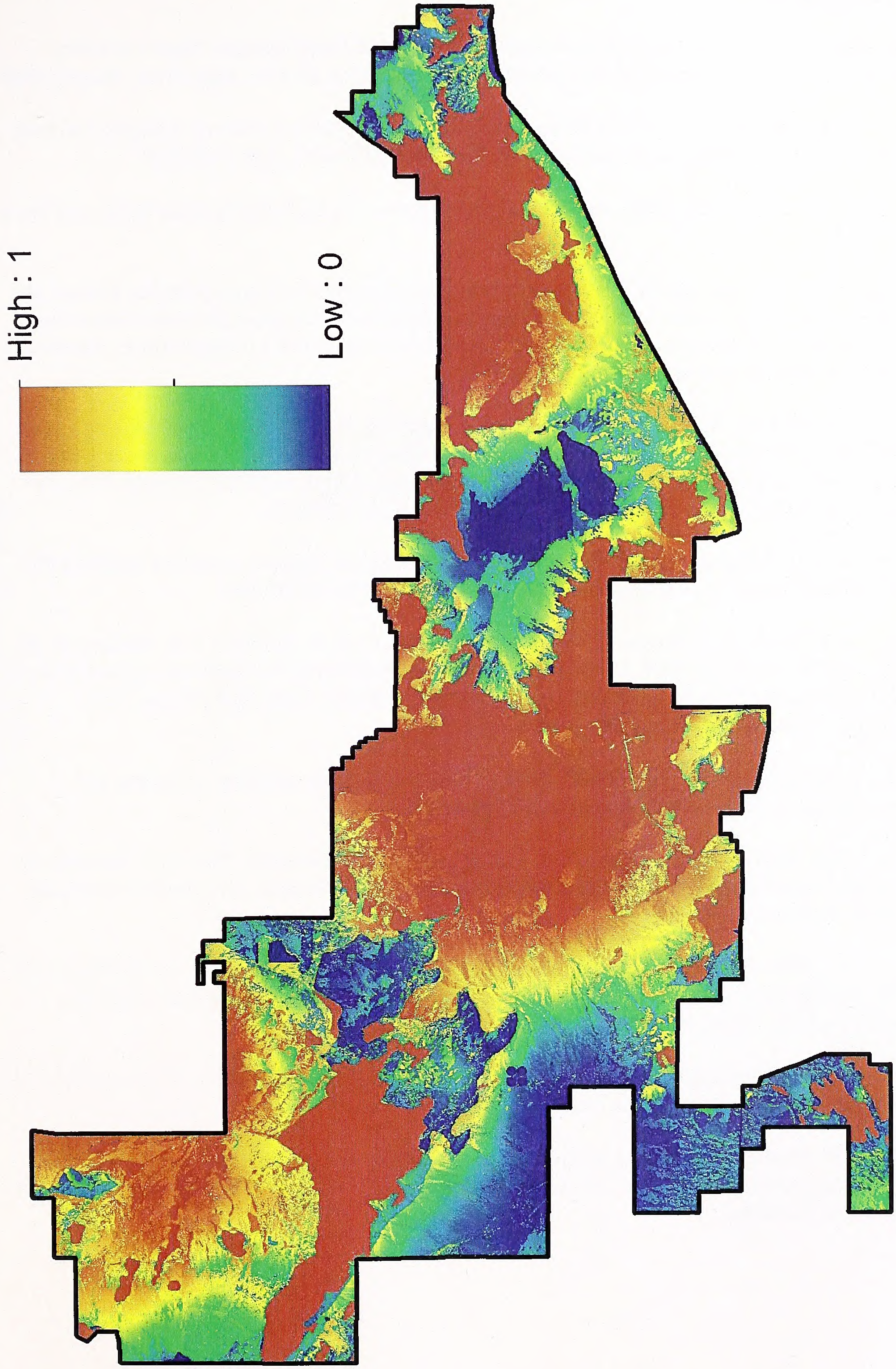

Figure B-1. Habitat model for the Superior-Cronese plan area.
The map colors indicate the probability (0.0-1.0) for desert tortoise occurrence based on the occurrence of habitat elements.

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Appendix C

Appendix C
Development of the Population Model

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Development of the Population Model

Michael Tuma and Chris Millington

1. INTRODUCTION

Population modeling techniques were used to simulate the effects of various threats to desert tortoise populations, and to prioritize their importance in limiting population growth. This information was then used to develop management prescriptions and priorities within the Superior-Cronese plan area. Since the desert tortoise is a long-lived species with long generation times, it could take decades to understand the long-term effect of threats to tortoise populations or conservation measures implemented for species recovery. Fortunately, recent advances in computer modeling have made it possible to simulate the effects of threats and their management on populations.

Population modeling is a technique that has been applied to turtle populations in pursuit of understanding population dynamics, particularly in response to threats of anthropogenic origin. Most population models are matrix models that use algebraic computations to compare vital rates (reproduction and survival) across age classes or life stages to assess population projections. These "stage-based" models focus primarily on identifying the vital rates among the various age classes that are most influential in causing population growth or decline, which allows for the development of conservation measures that target certain life stages. Stage-based population modeling was first applied to sea turtle populations to guide management practices toward at-risk life stages (Crouse et al. 1987; Heppell 1998; Crowder et al. 1994; Chaloupka 2002). Stage-based models have also been developed for terrestrial and freshwater turtle populations. For example, Mitro (2003) developed an age-classified population model for diamondback terrapins to determine which age class(es) would benefit most from conservation and management implementations.

While stage-based models estimate population projections based on the average rates of the entire population, individual-based models allow for simulations of local interactions of members of the population. Thus, behavioral parameters are a characteristic of these models. As well, the individuals are tracked through time, and the simulations consider all of the individuals separately rather than averaged for the whole population as is done using other models. Mazaris et al. (2005) used an individual-based model to simulate vital rate variations, particularly differences in reproductive output and survival among different age classes of loggerhead sea turtles to inform management practices for the species. Likewise, Mazaris and Matsinos (2006a) used an individual-based model to simulate the effects of variations in environmental conditions and population density on population persistence for green sea turtles, as well as the effects of differential survivorship on various age classes (Mazaris and Matsinos 2006b).

More recently, spatially-explicit models have been developed to examine dispersal movements and population connectivity in fragmented landscapes. Spatially-explicit models are useful for linking landscapes with demographic processes, and are particularly important for modeling movements across space and relative population densities across a variable environment. BenDor et al. (2009) examined connectivity between gopher tortoise populations using a spatially-explicit population model, and determined that even small amounts of habitat loss could lead to significant decrease in dispersion rates between populations. Similarly, Enneson and Litzgus (2009) determined using spatially-explicit population modeling techniques that isolated spotted turtle populations faced high risk of extirpation in the absence of dispersal between breeding ponds.

Three population models have previously been developed for the desert tortoise. Doak et al. (1994) used a stage-based modeling technique to evaluate the effects of management implementations for desert tortoise populations within the western and central Mojave Desert. They perceived rapidly declining populations in the study area, and concluded that conservation measures that reduced mortality of adult females would

have the greatest effect on long-term population viability. In contrast, Wisdom et al. (2000) used a stage-based modeling technique for desert tortoise populations and determined that both immature and adult tortoises should be targeted for conservation, as manipulation of multiple vital rates among various life stages resulted in population growth. Reed et al. (2009) reasoned that previous models were flawed because they assumed stable age distributions within populations, which is apparently not the case for desert tortoises (predation rates differ between age classes because of differential rates of predation, i.e., raven predation on juvenile tortoises). They employed an age class stage-based vital rate sensitivity analysis that allowed for an examination and evaluation of the effects of both short-term and long-term species management strategies. Rather than model the effects of threats on demographics, the authors modeled the effects of a variety of management prescriptions. They determined that management actions that target the adult age class were most effective for achieving both short-term and long-term management goals.

We used a modeling technique that has never been applied to desert tortoise populations: an individual-based, spatially-explicit population model. The computer software we used to model desert tortoise populations in the Superior-Cronese plan area is HexSim (Schumaker 2011). HexSim features a sophisticated graphical user interface that allows users to input landscape data, species life history and behavioral characteristics, and disturbances. The model is particularly suited for modeling terrestrial animal population response to multiple environmental stressors, including threats and disturbances of anthropogenic origin. HexSim can analyze threats that occur either spatially or probabilistically, or both. HexSim runs simulations over a time series defined by the user, and generates a number of reports, including population census data, vital rate data, and animal movements and dispersal, among others. It features a simulation viewer that allows users to view and display movies that illustrate animal movements and population dynamics.

2. MODELING STRATEGY AND PARAMETERS

The HexSim software suite is a collection of several programs and utilities used to construct, run, and analyze simulation models referred to as 'scenarios' (models). The following section describes the graphical interface—the primary program used for constructing the models. The graphical interface functions as an archive and stores spatial data and one or many models. The spatial environment, which includes the physical dimensions and boundaries of the modeling area, is standardized across all models displayed in each interface. All models include one or more populations and a series of 'events.' Traits must be assigned to all populations and are defined as either probabilistic or accumulated, and the values for these traits can change with respect to time and spatial data included in the model.

Once values for the spatial environment were determined, we built models by defining population parameters and constructing the series of events, which were then executed by the modeling engine from top-to-bottom as depicted in the Event Sequence (Figure C-1). The events simulated or defined basic biological features such as aging, reproduction, survival, and movement. The following sections describe the conceptual approach of the simulation effort and the assumptions and parameters built into the models.

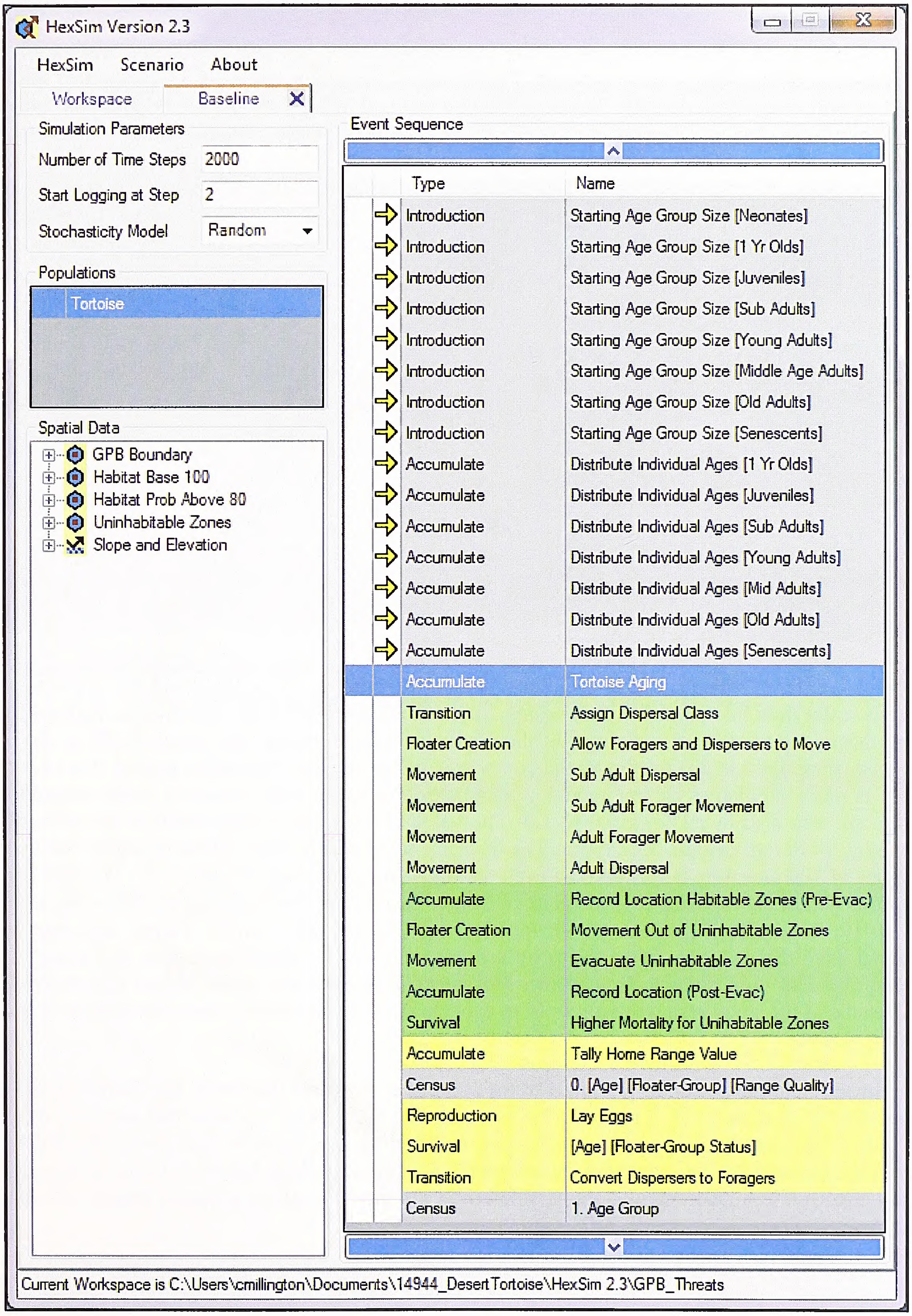

Figure C-1. HexSim graphical interface showing a sequence of events for an example model.

2.1.1 Modeling Strategy

The first step in our approach involved the construction of a baseline population model, on which subsequent threats models were compared. The baseline population model is a hypothetical model that simulates a tortoise population uninhibited by detrimental anthropogenic effects or significant fluctuations in environmental stochasticity (though the HexSim model incorporates a small amount of stochasticity). By removing external pressures and expanding the time scale beyond observable ranges, the baseline simulation depicted steady-state population equilibrium and thereby approximated the population carrying capacity of the modeled environment. The HexSim model is a female-only population model, and we accounted for this, particularly when parameterizing the reproductive rates. Having developed the baseline population model, we added threats models to simulate their effects to the population. Specifically, the threats were applied to the population at a point when the baseline population was at steady-state, thereby allowing for a standardized measure to compare the relative effects of individual threats. Multiple threats models were constructed that varied in intensity of effect (environmental degradation and/or increased mortality) in order to compare relative differences within each threat category. The parameters defining the baseline model and threats models are described below.

2.1.2 Landscape Parameters

The first step in creating the model required us to define the spatial environment. To standardize the spatial data imported into the model, we standardized the shape and boundaries of the modeled study area, and set the size and spatial extent of each hexagon in the model grid to a width of 150 m. This corresponded to an area of 1.95 ha for each hexagon, a resolution we considered appropriate for modeling the space use behaviors of desert tortoises. At this resolution, the modeled Superior-Cronese study area was comprised of 515,678 hexagons.

We imported spatial data into the HexSim spatial environment using the HexMap converter, which converts raster data into a lattice of hexagons that are each assigned a numerical value derived from the raster image. We used the raster image of the predictive habitat model (see Appendix B) as the primary base layer (baseline habitat) for the spatial component of the HexSim population model. The raster image of the original predictive habitat model is composed of 30 m cells (squares), each embedded with continuous data distributed from 0.0 to 1.0. The value in each cell corresponded to an increase in the probability of desert tortoise occurrence. The hexagon score within each 150-m hexagon was applied as the mode of 100 sampling points derived from the overlaid raster image (Figure C-2). We then converted the scores within the HexMap to a categorical, integer-based scale that included the following categories: 1-9; 10-19; 20-29; 30-39; 40-49; 50-59; 60-69; 70-79; 80-89; and 90-100. Values less than 20 were excluded from the use area for tortoises by scoring them as ‘1’ (purple hexagons in Figure C-3) and defining them as uninhabitable (see below, *Movement Behaviors and Home Range Construction*). The area outside of the study area was scored ‘0’ to exclude any tortoise activity from this area (grey hexagons in Figure C-3).

The scores within the hexagons pertained to the amount of available resources, and therefore, the greater probability of inhabitancy by a tortoise. We assumed that the primary resource that tortoises would seek out within their resource acquisition areas were cover sites, i.e., burrows and caves. We felt this was appropriate because the habitat model leaned heavily toward describing habitat in terms of burrowing and caving opportunities. Accordingly, we parameterized the model to allow a greater density of tortoises in areas that contained higher scores within hexagons.

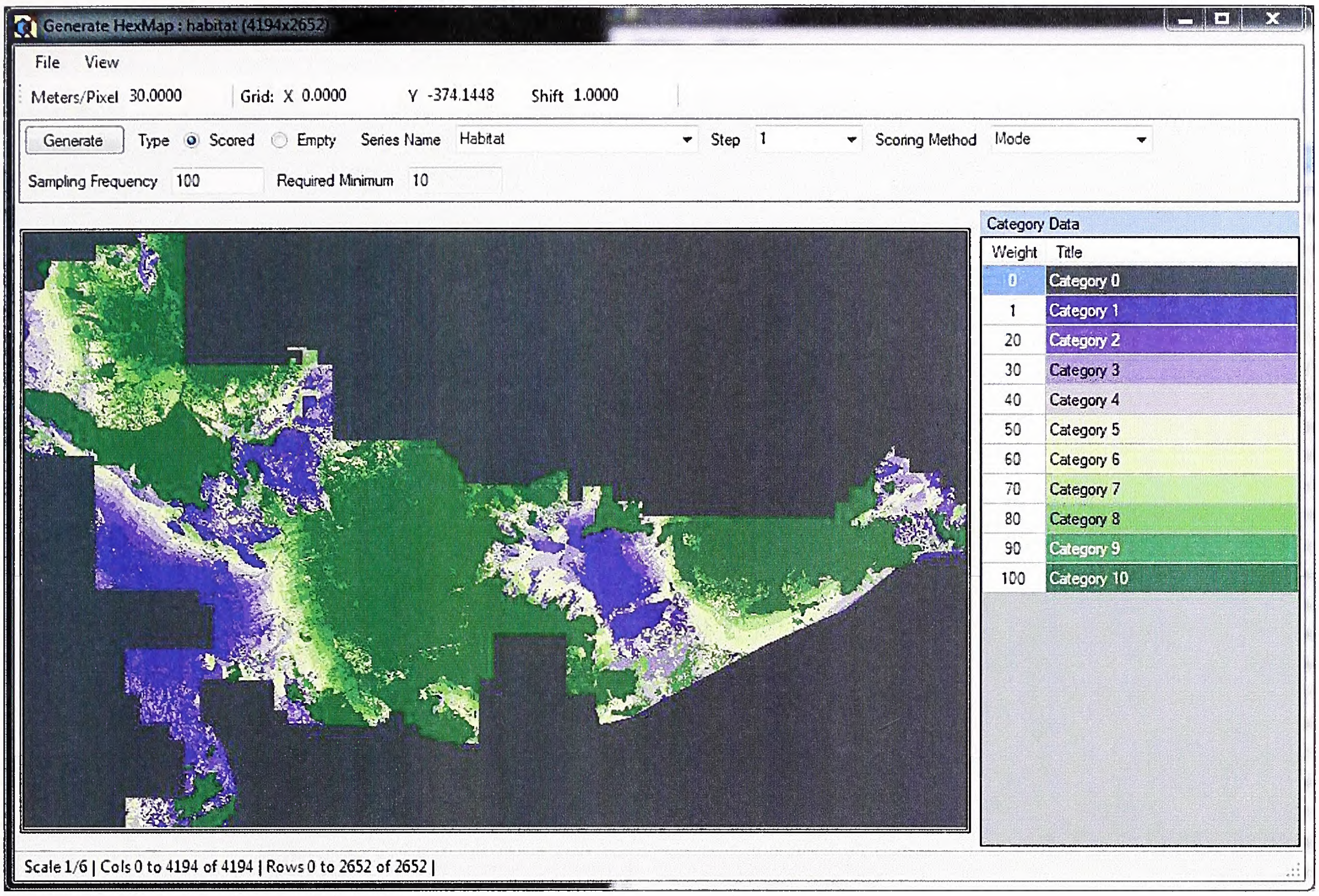

Figure C-2. Scoring hexagons in the baseline habitat HexMap.

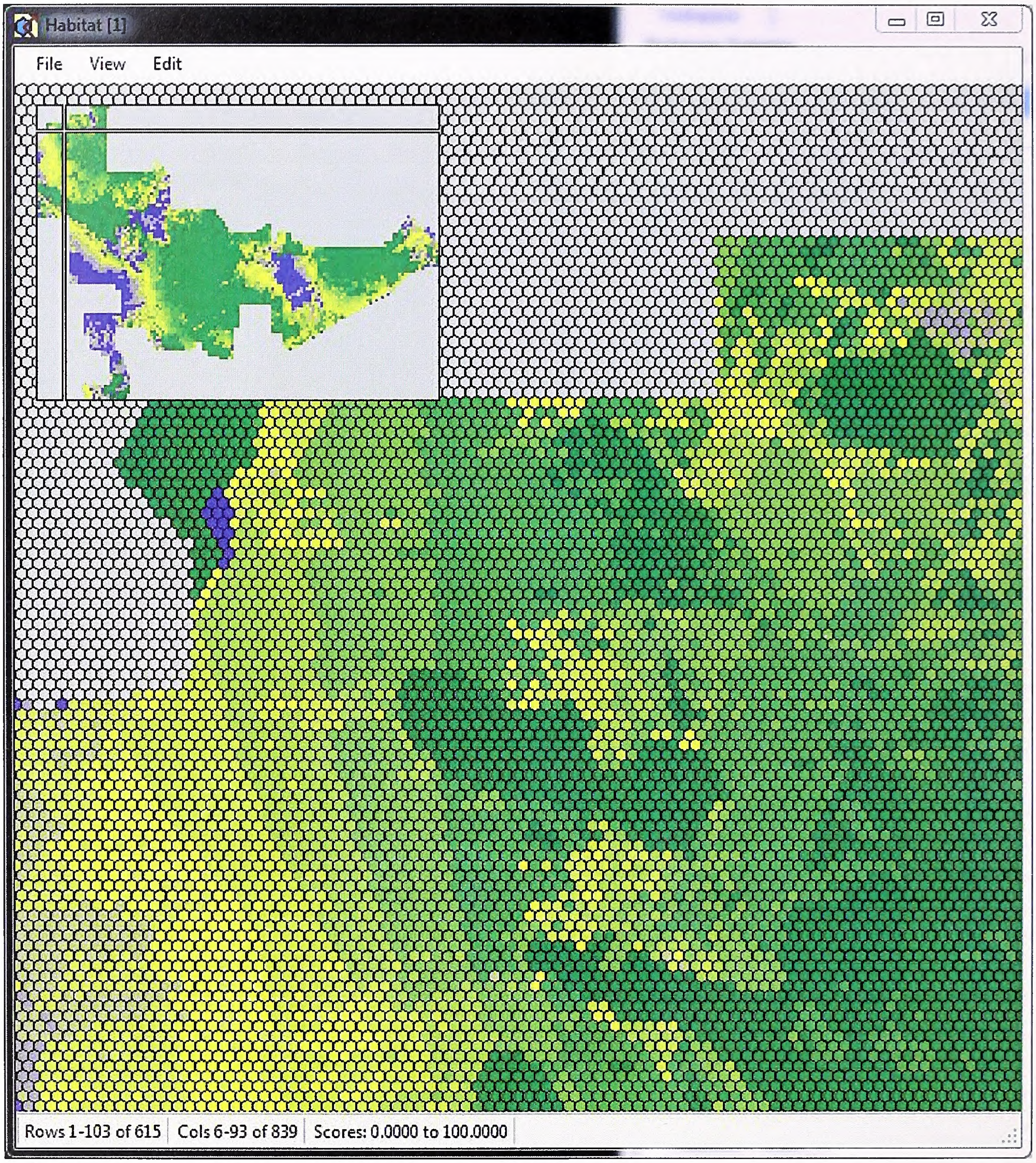

Figure C-3. Portion of the baseline habitat HexMap depicting uninhabitable zones (purple) and hexagons outside the study area (grey).

2.1.3 Population Density Control

The resource scores within each hexagon describe the amount of burrowing resources available to tortoises during each time step. The time steps within HexSim are unit-less values we defined as years. We parameterized tortoise behavior so it would be affected by the resource quality of the hexagons they

occupied. This allowed us to place limits on tortoise population density based on rules set for reproduction. We know from literature that a density of 50 tortoises per km^2 is achievable, so we set that density as our limit in the baseline model. Since the model is female only, we set the maximum density at 25 tortoises per km^2, or one tortoise per two hexagons (each hexagon is 1.95 ha). To achieve this maximum density, we parameterized tortoises to acquire a target resource value of 200. In other words, we assume hexagons scored 100 are capable of supporting the maximum population density of 50 tortoises per km^2.

We allowed females to acquire resources from a maximum of five hexagons per time step by setting both the 'range' and 'explored area' to five ('range' in HexSim corresponds to an ecological territory and 'explored area' corresponds to an ecological home range). HexSim allows explored areas (home ranges) to overlap, but ranges (territories) do not. In our model, each tortoise's range is derived from the explored area so that multiple tortoises are able to search for resources in the same location but ultimately only one tortoise will occupy a given area (i.e. have the hexagon included in their range). Since the highest resource value per hexagon is 100, one female can acquire her target resources within a minimum of two hexagons during each time step. In lower quality habitat (hexagon scores less than 100), females would need to occupy more hexagons to achieve a score of 200. Because there is a maximum limit of five hexagons in which the score of 200 can be achieved, the resource target will not be reached for any home range in which the maximum hexagon score in their explored area is below 40 (i.e. a deficient home range).

If a female is unable to achieve her target resource within five hexagons during a time step she becomes a 'floater.' In HexSim floaters do not reproduce. Furthermore, we imposed a decreased probability of survival (-0.01) for floaters, i.e. tortoises with deficient home ranges. In our model this is the primary mechanism used for imposing density-dependent feedback on population growth. All females who meet their resource targets are subject to the user-supplied reproduction rates (described below). Only adult female tortoises were required to acquire target resources; this allowed immature tortoises to occur within hexagons without limits on density, and without competing with adults.

We parameterized density control by assuming that hexagon scores scaled in equal proportion with carrying capacity, i.e. smaller areas of high quality habitat were able to support an equivalent number of tortoises in larger areas of low quality habitat. For example, two hexagons scored 100 were equivalent to five hexagons scored 40 with respect to the number of individuals that may be supported within an area. As another way to impose density control, we altered the vital rates (lowered survivorship and no reproduction for floaters) when the number of tortoises exceeded the amount of spatial resources available in a given area.

2.1.4 Vital rates

We developed age classes in a manner that allowed us to assign different vital rates (survivorship and reproduction) to each. Following is a discussion of the vital rates we incorporated into the HexSim model.

Survivorship

We set survivorship rates for all age classes of the modeled tortoise population. We based the survivorship of neonates upon field data presented by Bjurlin and Bissonette (2004). Data for other juvenile desert tortoise age classes are generally lacking, though studies of chelonian species indicate relatively high mortality until maturity (Wilbur and Morin 1988; Brooks et al. 1991; Congdon et al. 1993; 1994). We parameterized survivorship rates in a manner that gave increasing survivorship to increasingly older age classes, but also produced a stable population (Table C-1). In order to have modeled tortoises die of 'old age,' we reduced the survivorship of senescent individuals (those 80+ years old). This allowed tortoises to – in the absence of stochastic events – attain ages of between 80 and 100 years old (although tortoises could, though very rarely, attain ages exceeding 100 years).

We additionally depressed survivorship rates for certain behavioral categories. As previously mentioned, we depressed the survival rates for 'floater' tortoises that occupied deficient home ranges. Because floater status has significance primarily with respect to reproduction, immature tortoises (less than 16 years old) never became floaters, and thus, did not suffer lowered survivorship rates of floaters. Finally, we defined a unique survivorship rate for tortoises that could not disperse from very poor habitat, which we defined as areas where resource scores over a tortoise's range averaged less than 20 per hexagon. Tortoises that could not disperse from these areas within one time step were penalized with a lowered probability of survival (by -0.3) prior to being subjected to the survival rates listed in Table C-1.

Table C-1. Survival rates for tortoises in the baseline population model.

Age Class	Survivorship Rate
Neonates (0-1 year)	0.40
One-year olds (1-2 years)	0.50
Juveniles (2-6 years)	0.68
Subadults (7-16 years)	0.88
Young adults (16-29 years) [Floater]	0.96
Young adults (16-29 years)	0.97
Middle-aged adults (30-59 years) [Floater]	0.98
Middle-aged adults (30-59 years)	0.99
Old adults (60-79 years) [Floater]	0.98
Old adults (60-79 years)	0.99
Senescent adult (80+ years) [Floater]	0.73
Senescent adult (80+ years)	0.74

Reproductive Rates

We assigned reproductive rates to the mature tortoise age classes in a manner that approximated reproductive rates observed by various researchers across the range of Agassiz's desert tortoise (Table C-2). Using these data as a guide to parameterizing the reproductive rates of the modeled tortoises, we allowed tortoises to lay up to eight eggs per season (Table C-3). Since the HexSim model is a female-only model, the clutch sizes of the modeled tortoises were approximately one-half of what we expected naturally-occurring wild tortoises to produce. Thus, while previous researchers have determined that female tortoises produce (on average) between 4.87 and 8.38 eggs per season (Table C-2), our modeled tortoises produced (on average) between 2.5 and 4.83 eggs per season (Table C-3). To account for a proportion of females within populations that forego reproduction (Table C-2), we assigned a reproductive rate of 0.0 for a proportion of the modeled females (Table C-3). We assumed that younger adult females, because of their allocation of a relatively higher proportion of their annual energy budgets to growth, would forego reproduction more frequently than older females (Table C-3). Floaters were always assigned a reproductive rate of 0.0.

Table C-1. Reproduction rates for female desert tortoises at several Mojave Desert study sites.

Population	Study vicinity	Proportion of sample that did not reproduce	Mean clutch frequency	Size of first clutch	Size of second clutch	Size of third clutch	Mean number of eggs per female per year ± SD
Goffs – 1983 (Turner et al. 1986)	Eastern Mojave	0	1.89	4.1	4.25	2	Not reported
Goffs – 1984 (Turner et al. 1986)	Eastern Mojave	4%	1.57	4.29	4.27	0	Not reported
Goffs – 1985 (Turner et al. 1986)	Eastern Mojave	0	1.75	4.8	5.57	6	Not reported
Ward Valley – 1991 (Karl 1998)	Southeastern Mojave	13%	2	4.19	4.27	3	8.38±0.54
Ward Valley – 1992 (Karl 1998)	Southeastern Mojave	8%	1.84	3.19	3.52	1.5	6.68±0.57
Ward Valley – 1993 (Karl 1998)	Southeastern Mojave	10%	1.82	4.19	3.25	0	6.82±.042
Ward Valley – 1994 (Karl 1998)	Southeastern Mojave	28%	1.26	3.67	4.38	0	4.87±0.63
Ward Valley – 1995 (Karl 1998)	Southeastern Mojave	7%	1.68	4.08	3.77	3	6.76±0.47
Yucca Mountain – 1993-1995 (Mueller et al. 1998)	Northern Mojave	4%	1.5	5.1	4.8	0	7.9±0.8 (1993) 7.7±0.7 (1994) 6.7±0.7 (1995)
DTNA – 1992 (Wallis et al. 1999)	Western Mojave	0	1.67	4.4	4	0	7.1±2.7
DTNA – 1993 (Wallis et al. 1999)	Western Mojave	28%	1.76	3.9	4	0	7.0±2.5
Goffs – 1992 (Wallis et al. 1999)	Eastern Mojave	25%	1.7	4.2	4.1	0	7.1±2.8
Goffs – 1993 (Wallis et al. 1999)	Eastern Mojave	9%	1.67	4.2	4.7	0	7.3±3.1

Table C-2. Reproductive rates for tortoises (female-only model, so clutch sizes were halved).

Age class	Number of Eggs per Season									Mean Eggs per Season	SD	Max
	0	1	2	3	4	5	6	7	8			
Young adult	0.33	0.12	0.21	0.22	0.21	0	0	0	0	2.5	2.5	4
Middle-aged adult	0.20	0.06	0.14	0.21	0.21	0.14	0.04	0	0	3.5	3.5	6
Old adult	0	0.05	0.09	0.12	0.16	0.19	0.17	0.13	0.09	4.83	5	8
Senescent adult	0	0.05	0.09	0.12	0.16	0.19	0.17	0.13	0.09	4.83	5	8

2.1.5 Movement Behaviors and Home Range Construction

HexSim allows for dispersal and exploration (construction of home ranges) events, which we used to parameterize movement behaviors for modeled tortoises within home ranges, as well as for age-specific dispersal to new areas. These parameters were defined at the beginning of each time step, when the

modeled tortoises were probabilistically assigned to one of three movement classes: 1) foragers, 2) natal area dispersers, and 3) adult dispersers. We defined 'foragers' as those tortoises that move within home ranges; 'natal area dispersers' as subadults that dispersed from natal areas; and 'adult dispersers' as adult tortoises that made long-distance dispersal movements to new areas to establish new home ranges. For movement classes, we parameterized the maximum number of explorations, dispersal path lengths, directional probabilities, the influence of attraction and repulsion to spatial data, and stopping criteria, as described below.

Home Range

Adult tortoises assigned as 'foragers' at the beginning of a time step were allowed a maximum of four attempts to construct a home range (explored areas). Their goal was to acquire a resource target value of 200 from a maximum of five hexagons per explored area. We selected the adaptive exploration algorithm for foraging adult tortoises so that their home ranges tended to occur within higher quality habitat but allowed for some inclusion of lower quality habitat. We set maximum dispersal paths lengths to 150 m (2 hexagons) for adult foragers. With four exploration opportunities allowed per movement event, each tortoise was allowed to travel up to 1200 m (8 hexagons) in search of a sufficient home range during a time step. Since HexSim allows for prioritizing classes during movement events, we gave highest priority to the oldest tortoises, which allowed old adults and senescent adults to disperse and construct home ranges before middle-age and young adults. Thus, younger females were more likely to become floaters than older females. We parameterized the forager dispersal path direction to a random configuration by setting the autocorrelation parameter to 25%, allowing foragers to more thoroughly occupy an area. We set the home ranges of immature tortoises to one hexagon. We did not impose requirements for acquiring target resources for immature tortoises; in this way they did not compete with adults.

Dispersal from Natal Areas

We constructed a movement class, 'natal area dispersal,' which allowed immature tortoises to disperse from their natal areas. We created a probabilistic function that set a 0.13 probability that each subadult tortoise would be assigned to this movement category per time step. Since subadults were those tortoises between 10 and 16 years (time steps), on average 90% of them dispersed from natal areas using this function. We parameterized the distances moved during dispersal to a range scaling from 300 m (2 hexagons) to 2400 m (16 hexagons). We set the autocorrelation of direction of the dispersal path to 50%. Once dispersed, a subadult was assigned as a forager and assumed the subadult forager movement pattern. The remaining 10% of subadults that did not disperse were converted into subadult foragers within their natal areas. We set the subadult forager movement pattern to maximum path lengths of 300 m per movement, with the directional autocorrelation set to 25%. When a subadult matured (at time step 17), it took on the adult forager movement pattern.

Long-distance Adult Dispersal

We created a second movement event for adults that allowed them to make long-distance dispersals. We gave every adult a 0.5% chance that it would disperse from its explored area per time step. We parameterized the distances moved during dispersal to a range scaling from 2,250 m (15 hexagons) to 6,000 m (40 hexagons). We set the autocorrelation of direction of the dispersal path to 75%, which allowed for relatively straight movements. Once dispersed, the tortoise returned to the forager movement pattern and was not eligible for another dispersal event.

Attraction and Repulsion

We scored hexagons with attraction and repulsion parameters to guide tortoise movements away from some landscapes, such as uninhabitable areas where tortoises would not find the habitat elements necessary for resource extraction or survival. We defined these uninhabitable areas as those with hexagons scored less than 20. The adult dispersal movement event allowed tortoises to traverse lower

quality habitat in pursuit of a new home range but without being penalized by the surrounding habitat quality. However, since it was possible for dispersing tortoises to become "stuck" in these uninhabitable zones, we created a dispersal event called 'evacuate uninhabitable areas.' Distances moved during the evacuation dispersal event included a range scaling from 300 m (2 hexagons) to 6,000 m (40 hexagons). We set the autocorrelation of direction of the dispersal path to 80%. We also programmed values defining a 'stopping criteria' for this dispersal event. This function stopped movement when the mean resource score within the traversed hexagons was greater than 40 as experienced over two path lengths. For those tortoises still occupying uninhabitable zones after the evacuation event, we parameterized a penalty of a lowered survivorship rate by -0.3.

Barriers to Dispersal

We constructed barriers in areas of high slope and high elevation, which essentially prevented tortoises from passage. We used a 30-m digital elevation model to determine areas of elevation greater than 1,220 m (following Bury et al. 1994) and slopes greater than 40 degrees, where we constructed barriers (Figure C-4). Thus, barriers were constructed primarily in mountainous areas with precipitous slopes.

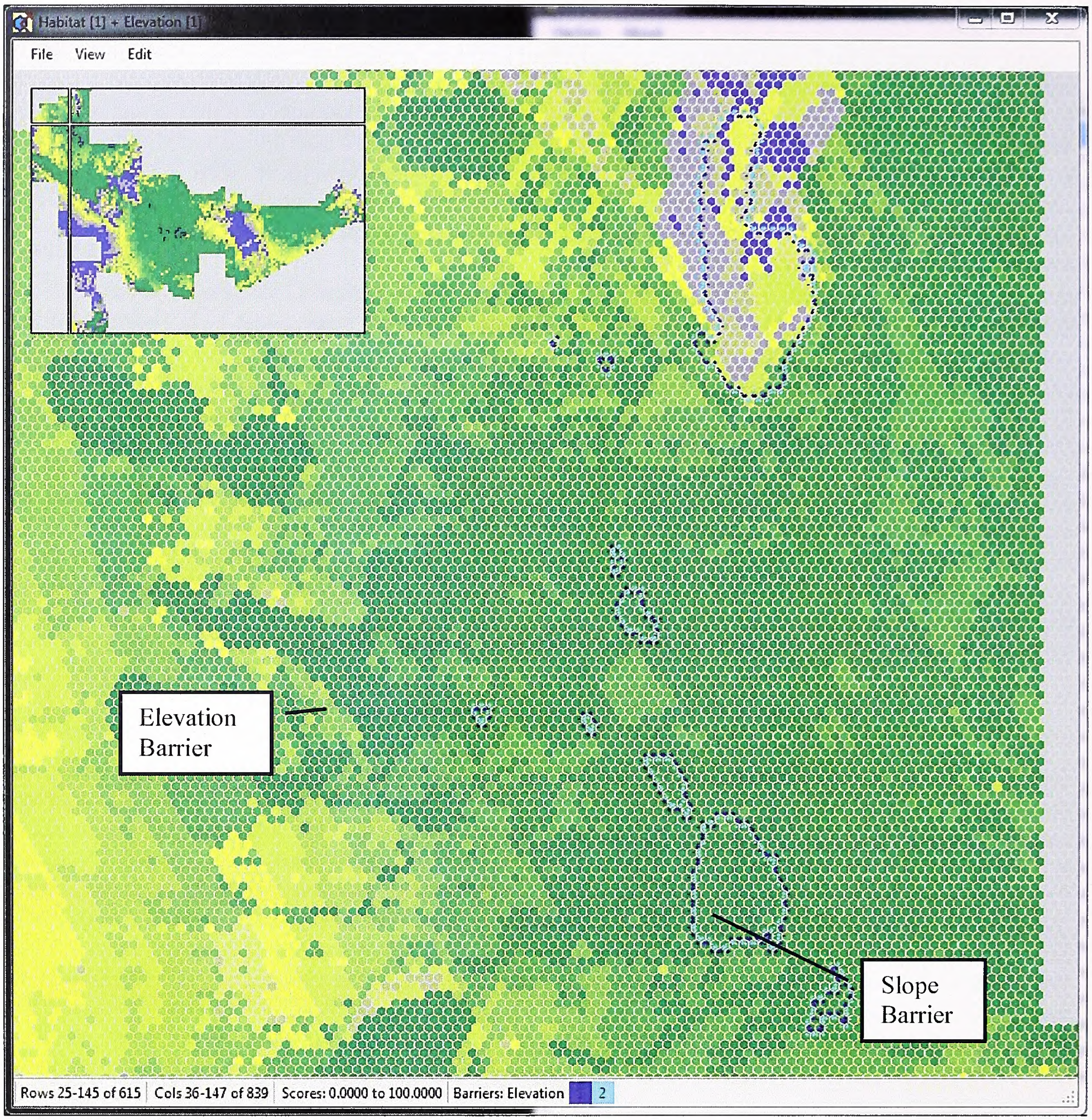

Figure C-4. Example of movement barriers in areas of high slope and high elevation.

2.2 Baseline Model

In order to validate parameters, identify unrealistic patterns or software-specific errors in events, and develop a final baseline model that produced a stable population, we constructed a series of baseline test models through an iterative process. The test models also allowed us to identify and correct biologically unrealistic behaviors and events, and to incorporate additional events or traits to better simulate reality. We incorporated a series of census events in the test models, which allowed us to validate proper functioning of events. The test models were particularly valuable for parameterizing survivorship rates among age classes, as these rates are generally unknown for wild populations.

Once we developed a population that achieved and maintained a stable state, we collected census data to determine population size and age class structure. The population size at the stable state was approximately 16,350 individuals, which was achieved whether the starting population was lower or higher. At stable state, the proportion of individuals among age classes was distributed as detailed in Table C-4. These proportions were then applied to the starting conditions for all subsequent models. Individuals were randomly assigned specific ages within each age group at start-up, and distributed randomly in space within hexagons scored 80 or above, i.e. high quality habitat. The final baseline model exhibited variation due to a degree of stochasticity built into the HexSim model (Figure C-5).

Table C-4. Ratio of individuals in respective age-groups used for starting conditions.

Neonate (0-1)	1 Year Old (1-2)	Juvenile (2-7)	Sub Adult (7-15)	Young Adult (16-30)	Middle Age Adult (31-60)	Old Adult (60-80)	Senescent (80+)
0.27	0.14	0.25	0.11	0.08	0.1	0.05	0.01

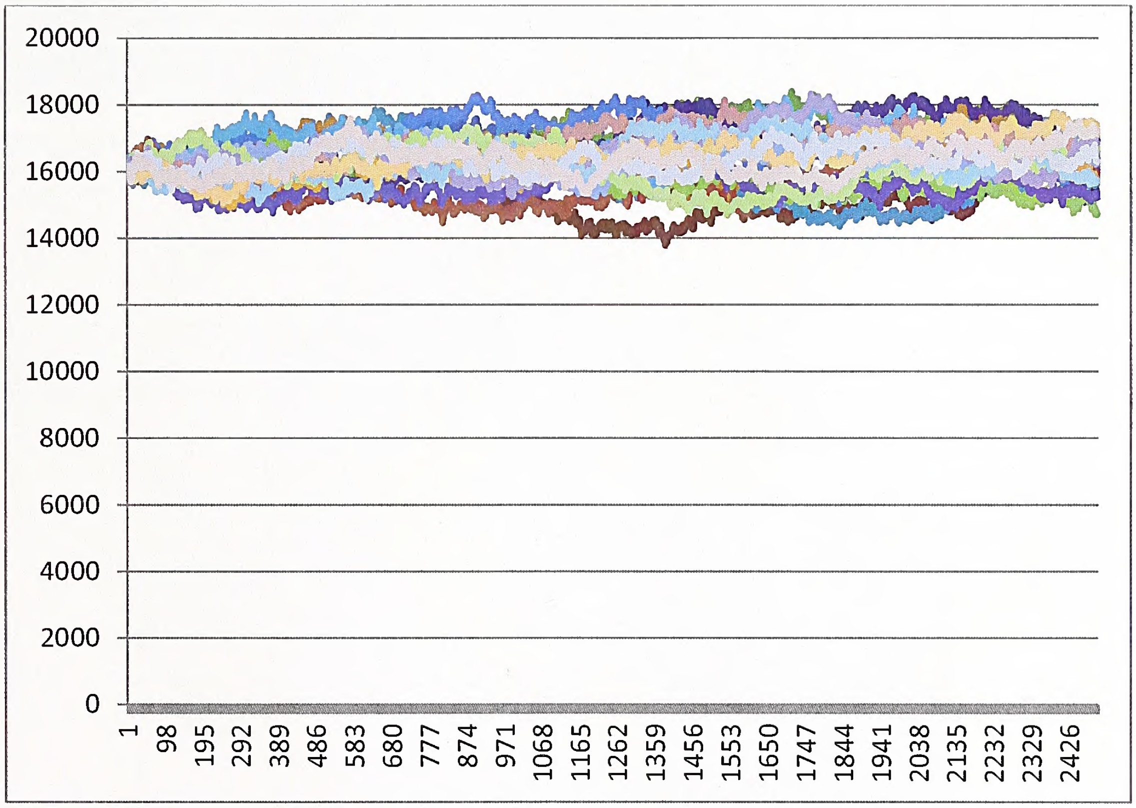

Figure C-5. Evidence of stochastic variability among 20 replicates of the baseline model. The average starting population size for the 20 replicates is 15,983.

2.3 THREATS MODELING

We modeled several of the more important threats to desert tortoise populations within the Superior-Cronese plan area, including: 1) habitat degradation on land in-holdings, 2) disease, 3) subsidized predators, and 4) human presence. For each of the threats models, we introduced mortality and/or habitat degradation into the baseline population model. We simulated habitat degradation by subtracting hexagon scores from the baseline habitat HexMap, and increased mortality by lowering the survivorship of tortoises. We constructed multiple models for each threat that included varied scales of habitat degradation and mortality, from low effect to severe effect. Our approach to modeling each of the threats is presented below.

2.3.1 Habitat Degradation on Land In-holdings

A significant portion (224,744 acres) of the Superior-Cronese plan area includes privately-owned land in-holdings (Figure C-6). These areas are outside of the management control of the BLM, and could potentially be developed or converted to a land use that is inconsistent with the management of federal lands within the plan area. Two additional land in-holdings (totaling 8,690 acres) are managed by the Department of Defense, and could potentially receive more intensive military use. We simulated the effects of habitat degradation on these land in-holdings by degrading desert tortoise habitat within them. We constructed six models with increasing amounts of degradation until habitat values reached the lowest level of habitat quality capable of sustaining a population (i.e., the highest score within hexagons was 40) (Table C-5). We maintained the same mortality rates that were set the baseline model for each threat model.

Table C-5. Parameterization of resource scores within hexagons among six scenarios of habitat degradation on land in-holdings.

Scenario	Hexagon Value Subtracted from Baseline Habitat	Modified Hexagon Score*								
Baseline	--	20	30	40	50	60	70	80	90	100
1	10	10	20	30	40	50	60	70	80	90
2	20	0	10	20	30	40	50	60	70	80
3	30	0	0	10	20	30	40	50	60	70
4	40	0	0	0	10	20	30	40	50	60
5	50	0	0	0	0	10	20	30	40	50
6	60	0	0	0	0	0	10	20	30	40

* Modifications that resulted in negative values for hexagons were converted to scores of 1 and categorized as an uninhabitable zone.

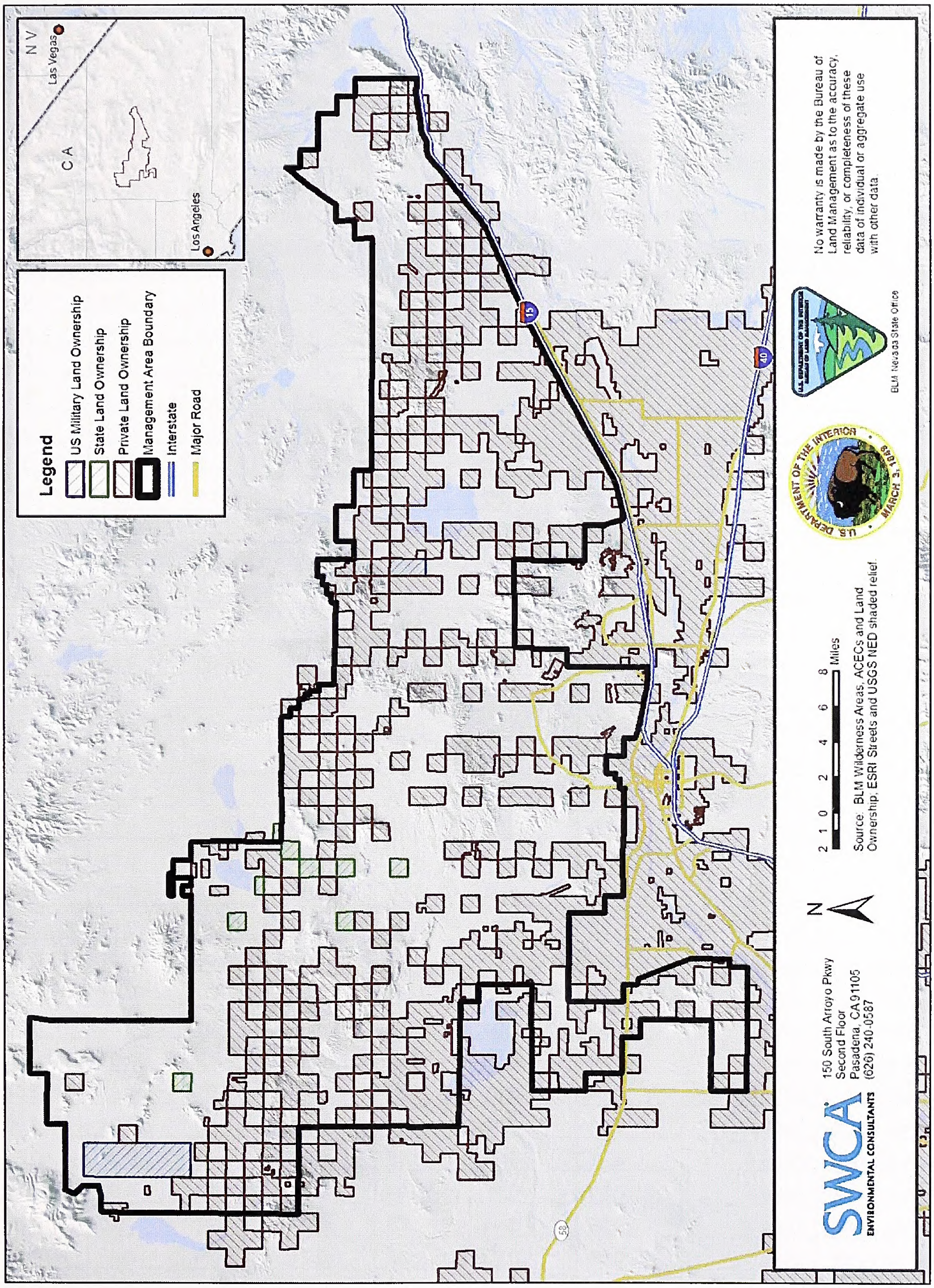

Figure C-6. Distribution of private, state, and federal land ownership within the plan area boundaries.

2.3.2 Disease

We simulated the effects of cyclical URTD epidemics by causing an increase in mortality near areas known to cause a higher incidence of the disease, and zones of increasing survivorship with increased distance from these areas (Figure C-7). We cycled the epidemics to occur during a five-year period every thirty years. We modeled the effects of varying levels of severity of the modeled epidemics by varying the mortality rates (Table C-6). Following Wendland et al. (2010), we restricted the disease incidence and increased mortality rates over the baseline model to adult tortoises only.

Table C-6. Survival parameters used in disease scenarios of varying epidemiological severity.

Age	Exposure	1	2	3	4	5	6	7
Neonate	Unexposed	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Neonate	Zone 4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Neonate	Zone 3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Neonate	Zone 2	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Neonate	Zone 1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
1-Year Old	Unexposed	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1-Year Old	Zone 4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1-Year Old	Zone 3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1-Year Old	Zone 2	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1-Year Old	Zone 1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Juvenile	Unexposed	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Juvenile	Zone 4	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Juvenile	Zone 3	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Juvenile	Zone 2	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Juvenile	Zone 1	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Sub Adult	Unexposed	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Sub Adult	Zone 4	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Sub Adult	Zone 3	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Sub Adult	Zone 2	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Sub Adult	Zone 1	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Young Adult	Unexposed	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Young Adult	Zone 4	0.96	0.95	0.94	0.93	0.92	0.91	0.9
Young Adult	Zone 3	0.95	0.94	0.93	0.92	0.91	0.9	0.89
Young Adult	Zone 2	0.94	0.93	0.92	0.91	0.9	0.89	0.88
Young Adult	Zone 1	0.93	0.92	0.91	0.9	0.89	0.88	0.87
Middle-Age Adult	Unexposed	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Middle-Age Adult	Zone 4	0.97	0.96	0.95	0.94	0.93	0.92	0.91
Middle-Age Adult	Zone 3	0.96	0.95	0.94	0.93	0.92	0.91	0.9
Middle-Age Adult	Zone 2	0.95	0.94	0.93	0.92	0.91	0.9	0.89
Middle-Age Adult	Zone 1	0.94	0.93	0.92	0.91	0.9	0.89	0.88
Old Adult	Unexposed	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Old Adult	Zone 4	0.97	0.96	0.95	0.94	0.93	0.92	0.91

Age	Exposure	1	2	3	4	5	6	7
Old Adult	Zone 3	0.96	0.95	0.94	0.93	0.92	0.91	0.9
Old Adult	Zone 2	0.95	0.94	0.93	0.92	0.91	0.9	0.89
Old Adult	Zone 1	0.94	0.93	0.92	0.91	0.9	0.89	0.88
Senescent Adult	Unexposed	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Senescent Adult	Zone 4	0.73	0.72	0.71	0.7	0.69	0.68	0.67
Senescent Adult	Zone 3	0.72	0.71	0.7	0.69	0.68	0.67	0.66
Senescent Adult	Zone 2	0.71	0.7	0.69	0.68	0.67	0.66	0.65
Senescent Adult	Zone 1	0.7	0.69	0.68	0.67	0.66	0.65	0.64

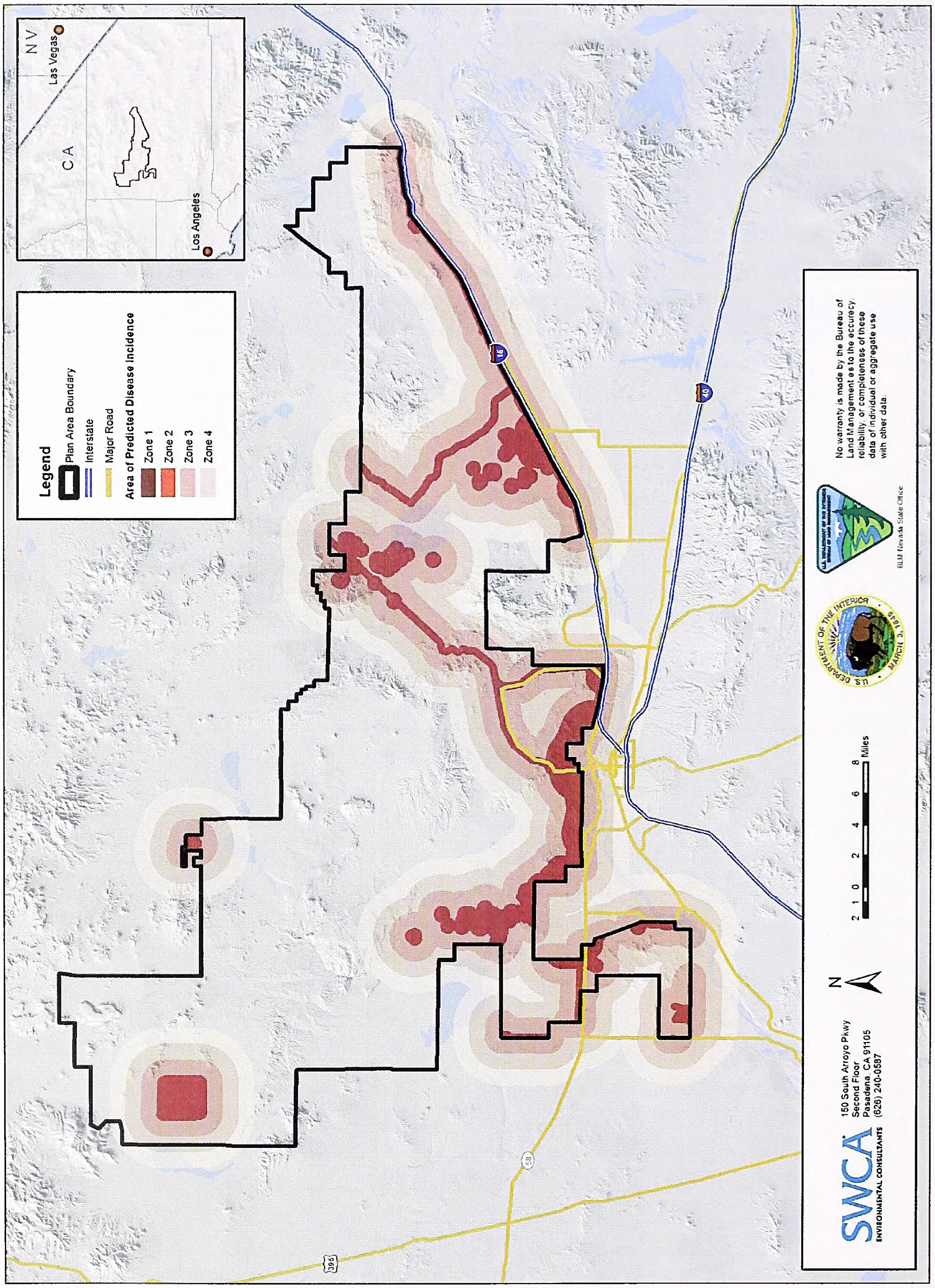

Figure C-7. Areas of modeled disease incidence and increased mortality rates in the Superior-Cronese plan area.

2.3.3 Subsidized Predators

We simulated the effects of subsidized predators by decreasing survivorship in affected areas. Affected areas were those where we predicted subsidized predator populations in the vicinity of anthropogenic food and water sources. We modeled affected areas by placing buffers around features that provide subsidies for ravens and coyotes (as well as other canids). These included urbanized areas, landfills, and open sources of anthropogenic water (including cattle troughs) (Figure C-8). The buffer (4.46 km) was based upon the Boarman et al. (1995) study of telemetered ravens and their use of human subsidies in the western Mojave Desert. Though there are no data for distances that coyotes range from human subsidies into adjacent desert areas, we modeled the same distance used for ravens. We modeled the effect of increased raven predation on tortoises less than 110 mm in length in affected areas using three scenarios of varying severity (Table C-7). We modeled the effect of increased coyote and feral dog predation on all age classes in affected areas, also using three scenarios of varying severity (Table C-8).

Table C-7. Survival parameters used for scenarios of raven predation. The survival rates were changed only for age classes of tortoises less than 110mm in length (neonate, one-year olds, and juveniles).

Age Class	Baseline	Scenario 1a	Scenario 1b	Scenario 1c
	l_x	$l_x - 0.1$	$l_x - 0.15$	$l_x - 0.2$
Neonates	0.4	0.3	0.25	0.2
1-Year Old	0.5	0.4	0.35	0.3
Juvenile	0.68	0.58	0.53	0.48
Sub Adult	0.88	0.88	0.88	0.88
Young Adult (Floater)	0.96	0.96	0.96	0.96
Young Adult	0.97	0.97	0.97	0.97
Middle-Age Adult (Floater)	0.98	0.98	0.98	0.98
Middle-Age Adult	0.99	0.99	0.99	0.99
Old Adult (Floater)	0.98	0.98	0.98	0.98
Old Adult	0.99	0.99	0.99	0.99
Senescent (Floater)	0.73	0.73	0.73	0.73
Senescent	0.74	0.74	0.74	0.74

Table B-8. Survival parameters used for scenarios of coyote and feral dog predation.

Age Class	Baseline	Scenario 2a	Scenario 2b	Scenario 2c
	l_x	$l_x - 0.1$	$l_x - 0.15$	$l_x - 0.2$
Neonates	0.4	0.3	0.25	0.2
1-Year Old	0.5	0.4	0.35	0.3
Juvenile	0.68	0.58	0.53	0.48
Sub Adult	0.88	0.78	0.73	0.68
Young Adult (Floater)	0.96	0.86	0.81	0.76
Young Adult	0.97	0.87	0.82	0.77
Middle-Age Adult (Floater)	0.98	0.88	0.83	0.78
Middle-Age Adult	0.99	0.89	0.84	0.79
Old Adult (Floater)	0.98	0.88	0.83	0.78
Old Adult	0.99	0.89	0.84	0.79
Senescent (Floater)	0.73	0.63	0.58	0.53
Senescent	0.74	0.64	0.59	0.54

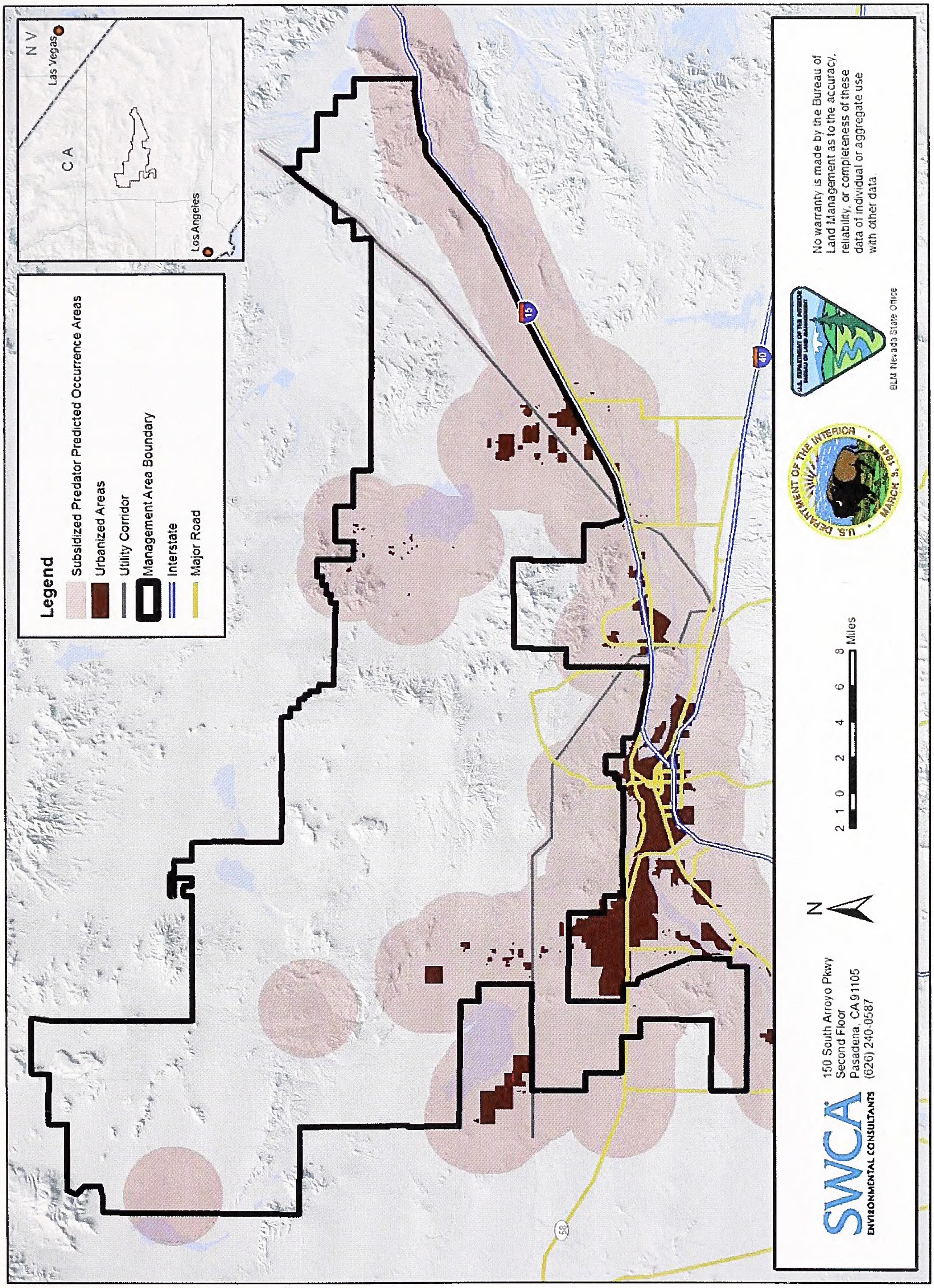

Figure C-8. Modeled areas of increased subsidized predator effect on desert tortoise populations within the Superior-Cronese plan area.

2.3.4 Human Presence

We simulated the effects of human presence by degrading desert tortoise habitat and decreasing survivorship in affected areas. Affected areas were those where we predicted increased human presence within the plan area, including lands adjacent to urbanized areas, roads, OHV trails, mines, utilities, military training areas, and other human developments (Figure C-9). We placed buffers of 1500 m around urban areas and homestead developments, 50 m around OHV trails, and varying distances from roads, according to von Seckendorff Hoff and Marlow (2002) (Table C-9). We constructed a total of 12 models that tested six levels of habitat degradation and two levels of increased mortality (Tables C-10 and C-11).

We modeled varying effects on habitat degradation until the highest score within hexagons was 30, the point at which all tortoises inhabiting the area would be converted to floaters. The six scenarios of habitat degradation combined with three scenarios of survivorship to produce 18 human presence models.

Table C-9. Assignment of Mortality Sink Distances to Roads within and Adjacent to the Plan Area

Road	AADT* (2008)	Comparable to (von Seckendorff Hoff and Marlow 2002)	ADT† (1992)	Distance to 90% Asymptote
Interstate 15	37,500 – 70,000	U.S. Route 95 (4-lane highway)	5,210	4,250 m
Fort Irwin Road	3,908	State Route 163 (4-lane highway)	4,610	2,650 m
State Route 58	11,000	State Route 163 (4-lane highway)	Unknown	4,250 m
Old Highway 58	Unknown	State Route 165 (2-lane highway)	Unknown	2,250 m

* Annual average daily traffic
† Average daily traffic

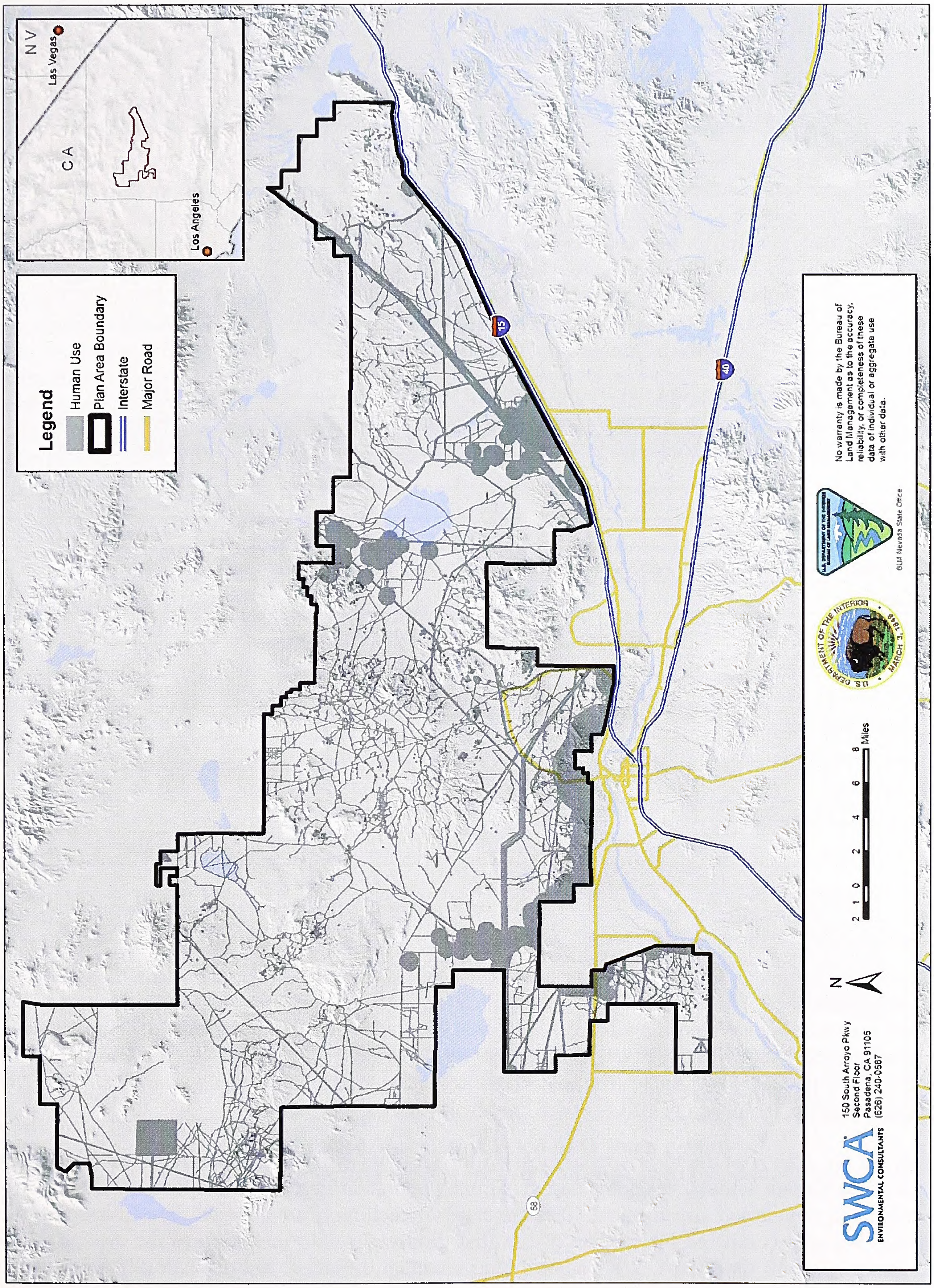

Figure C-9. Modeled area of increased human presence within the Superior-Cronese plan area.

Table C-10. Parameterization of habitat degradation among six scenarios of human presence.

Scenario	Hexagon Value Subtracted from Baseline Habitat	Modified Hexagon Score								
Baseline	--	20	30	40	50	60	70	80	90	100
1	10	1	10	20	30	40	50	60	70	80
2	20	1	1	10	20	30	40	50	60	70
3	30	1	1	1	10	20	30	40	50	60
4	40	1	1	1	1	10	20	30	40	50
5	50	1	1	1	1	1	10	20	30	40
6	60	1	1	1	1	1	1	10	20	30

Table C-11. Survival parameters among three scenarios of human presence.

Age Class	Baseline	Scenario 1	Scenario 2
	l_x	l_x - 0.01	l_x - 0.05
Neonates	0.4	0.39	0.35
1-Year Old	0.5	0.49	0.45
Juvenile	0.68	0.67	0.63
Sub Adult	0.88	0.87	0.83
Young Adult (Floater)	0.96	0.95	0.91
Young Adult	0.97	0.96	0.92
Middle-Age Adult (Floater)	0.98	0.97	0.93
Middle-Age Adult	0.99	0.98	0.94
Old Adult (Floater)	0.98	0.97	0.93
Old Adult	0.99	0.98	0.94
Senescent (Floater)	0.73	0.72	0.68
Senescent	0.74	0.73	0.69

2.4 Analysis Methods

We developed a series of 10 replicates for each of the threats scenarios. The subsidized predators and habitat degradation on land in-holdings models consisted of six scenarios, thus 60 replicates were performed for each. We developed a total of 70 replicates for seven disease scenarios and 90 replicates for nine human presence scenarios. We ran each replicate for 2,500 time steps. We ran the baseline model for the first 1,000 time steps, and introduced the threats scenarios at the 1,001st time step. The final 1,500 time steps, therefore, included the effects of the introduced threats.

We analyzed the effects of the threats by comparing the absolute difference between the baseline model and each of the threats models. We compared maximum population size within the first 1,000 time steps to the minimum population size in the 1,500 time steps of each replicate after the threats scenario was introduced. We also compared the median of the first group of 1,000 time steps to the median of the second group of 1,500 time steps. We analyzed the maximum difference and median difference scores using analysis of variance (ANOVA). We developed a Bonferroni-corrected multiple comparison following the ANOVA. We also developed descriptive statistics (means and ranks) for each threat scenario.

3. RESULTS

Each of the modeled threats affected the baseline model differently, though all of the threats caused population decline. The most severe threat model, or the model that caused the most precipitous and significant decline of the baseline population model, was human presence (Figure C-10). The second most important modeled threat in causing decline of the baseline population was subsidized predators (Figure C-11), followed by the disease (Figure C-12), and habitat degradation on land in-holdings (Figure C-13) models. Each of the threats models produced declines that were statistically different from the baseline model. The descriptive statistics, which included the means of the maximum and median differences between the baseline model (first 1,000 time steps) and the threats scenarios (time steps 1,001 through 2,500) are presented in Table C-12. The ANOVA showed that the differences between the threats scenarios, both by maximum difference (F[3, 416, 419]=1,342.9, p<0.001) and median difference (F[3, 416, 419]=1,798.2, p<0.001), were significant (Table B-13). In addition, each of the threats models produced population declines that were largely significantly different from each other, which allowed us to confidently rank their importance in producing population decline. The Bonferroni multiple comparison correction indicated significant differences between each of the threats models when comparing median differences; however, when comparing maximum differences the human presence and subsidized predator models were not significantly different from each other, nor were the disease and habitat degradation on land in-holdings models significantly different from each other (Table C-14).

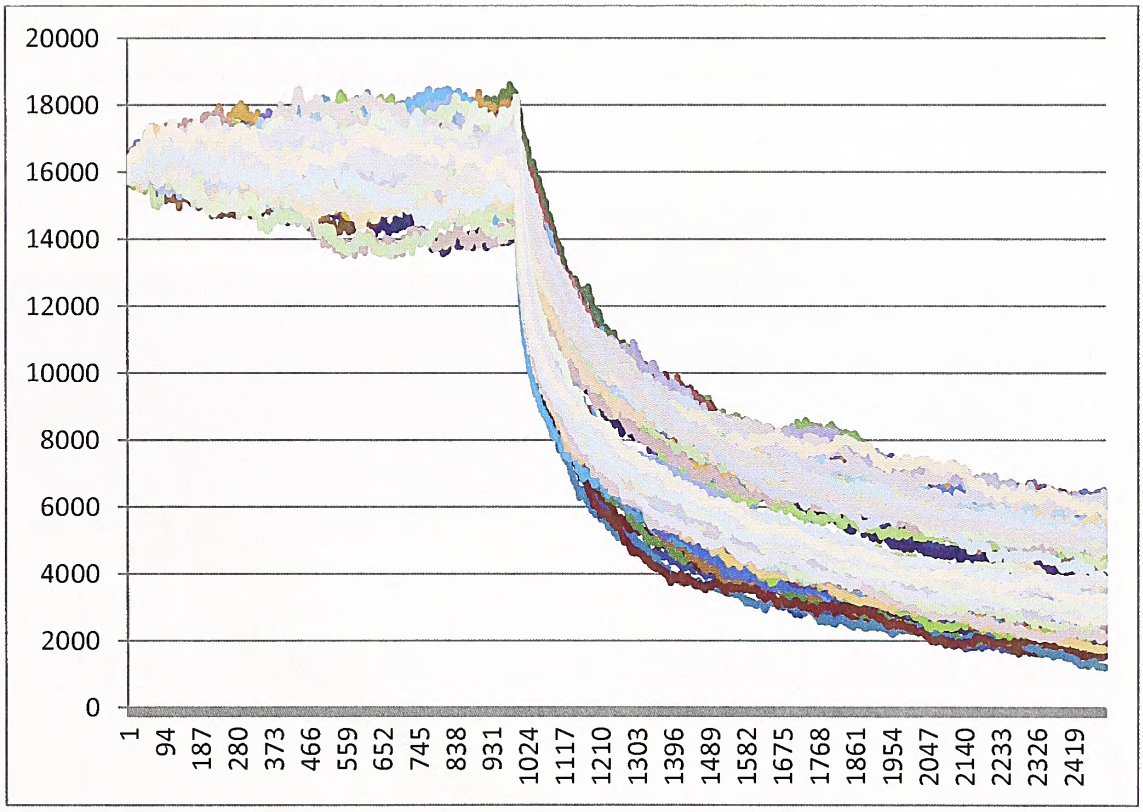

Figure C-10. Population trend for human presence.
The threats scenarios (n=12) were introduced at the 1,001st time step.

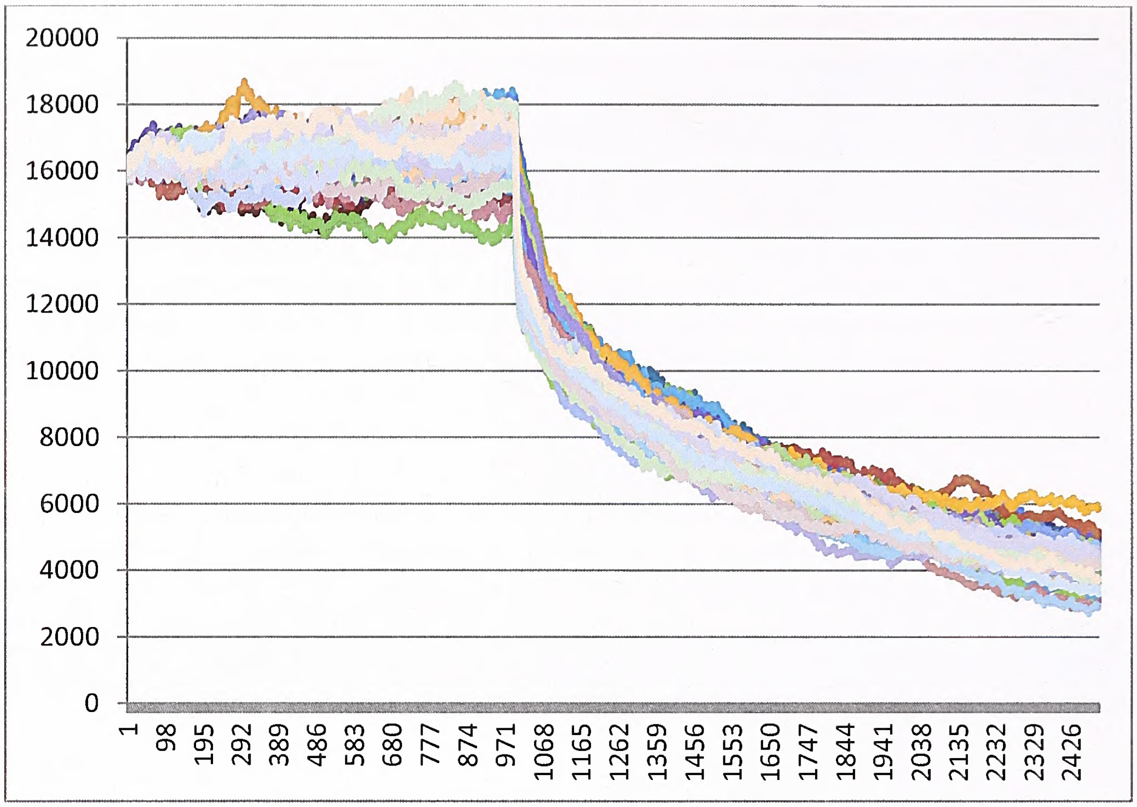

Figure C-11. Population trend for subsidized predators.
The threats scenarios (n=6) were introduced at the 1,001st time step.

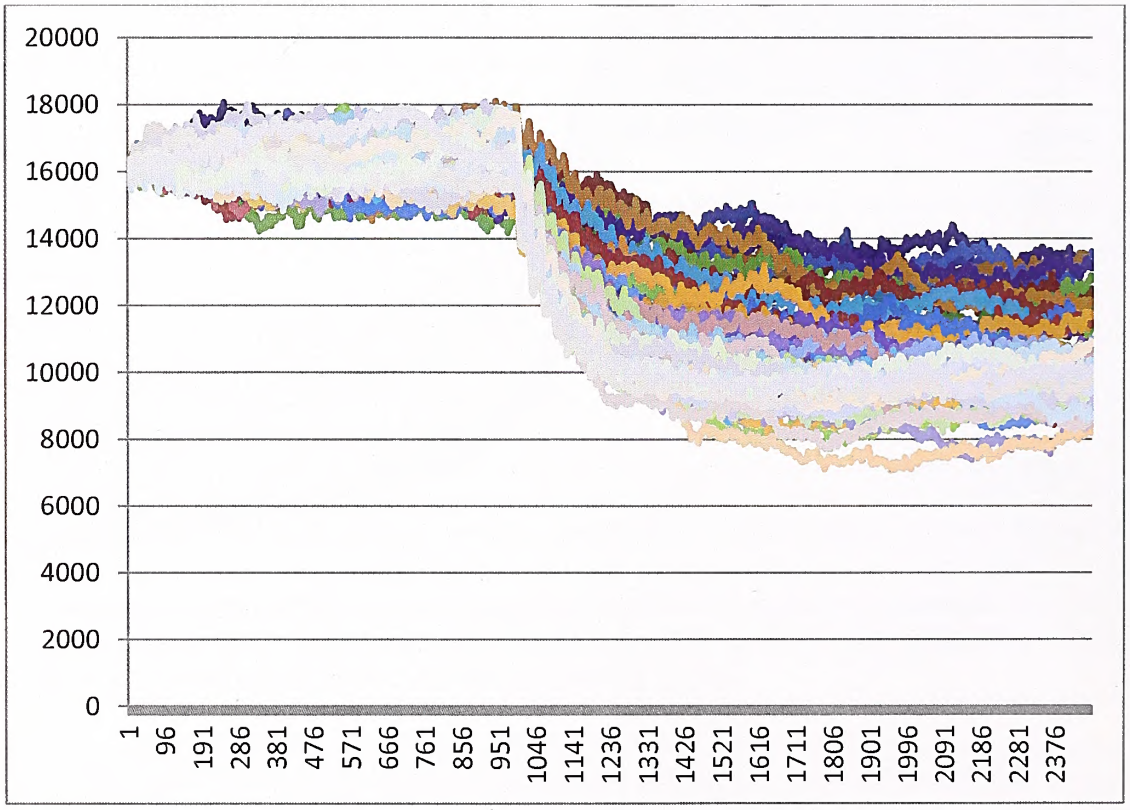

Figure C-12. Population trend for disease.
The threats scenarios (n=7) were introduced at the 1,001st time step.

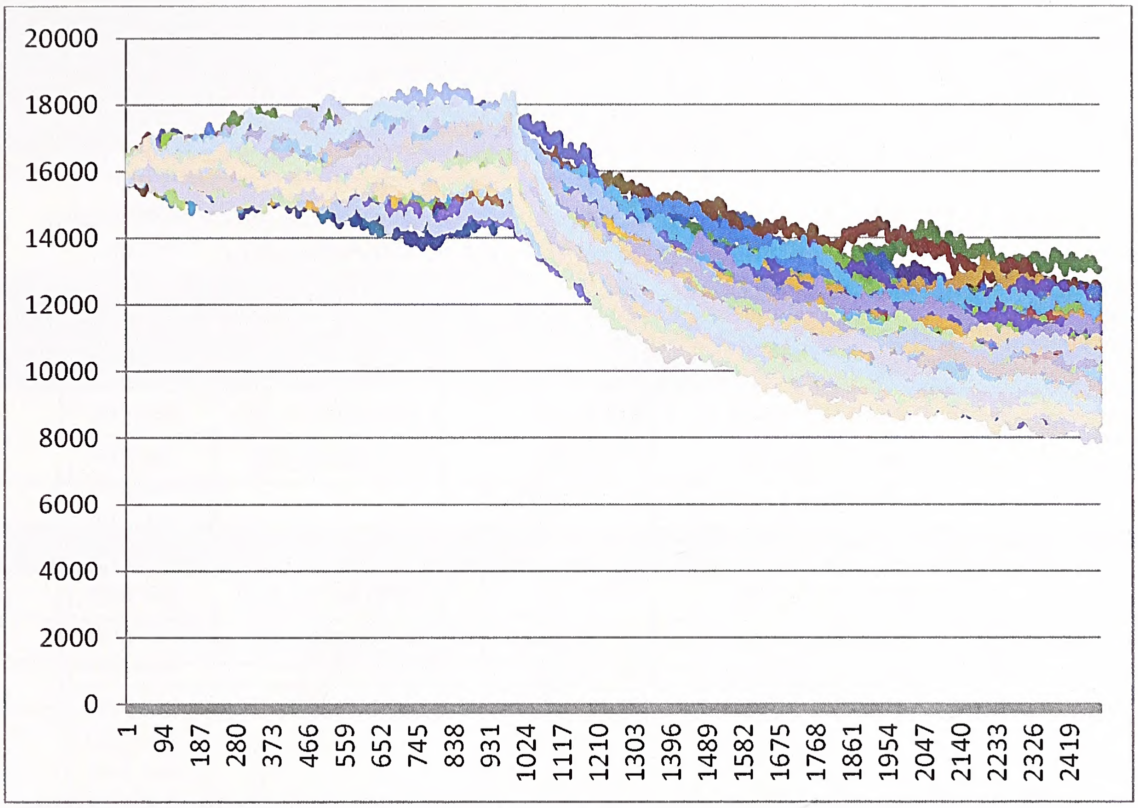

Figure C-13. Population trend for habitat degradation on land in-holdings. The threats scenarios (n=6) were introduced at the 1,001st time step.

Table C-12. Means of the maximum and median differences between the baseline model and threats scenarios.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean: Lower Bound	95% Confidence Interval for Mean: Upper Bound	Minimum	Maximum
Maximum difference								
Human Presence	120	13455.6167	1522.37145	138.97286	13180.4365	13730.7968	10731.00	16314.00
Subsidized Predators	60	13228.1500	737.01197	95.14784	13037.7596	13418.5404	11586.00	15317.00
Disease	70	7505.5286	1269.11706	151.68850	7202.9183	7808.1389	4600.00	9718.00
Habitat Degradation on Land In-holdings	60	7143.7333	1361.03881	175.70935	6792.1397	7495.3269	4044.00	9897.00
Total	**310**	**10845.3677**	**3262.75545**	**185.31206**	**10481.7346**	**11211.0009**	**4404.00**	**16314.00**
Median difference								
Human Presence	120	10668.6167	1577.60473	144.01495	10383.4527	10953.7807	7627.00	13654.00
Subsidized Predators	60	9965.5333	650.85148	84.02456	9797.4006	10133.6661	8434.00	11279.00
Disease	70	5464.1714	1373.11702	164.11887	5136.7632	5791.5796	2458.00	7925.00

Habitat Degradation on Land In-holdings	60	4367.500	1286.12247	166.03770	4035.2593	4699.7407	1543.00	7291.00
Total	**310**	**8137.7677**	**3048.25461**	**173.12923**	**7797.1064**	**8478.4291**	**1543.00**	**13654.00**

Table C-13. ANOVA of the means of the maximum and median differences between the baseline model and threats scenarios.

	Sum of Squares	df	Mean Square	F	Sig.
Maximum difference					
Between Groups	2761209336.885	3	920403112.295	533.140	<0.001
Within Groups	528272759.193	306	1726381.566		
Total	**3289482096.077**	**309**			
Median difference					
Between Groups	2322330515.035	3	774110171.678	431.587	<0.001
Within Groups	548853040.243	306	1793637.386		
Total	**2871183555.277**	**309**			

Table C-14. Bonferroni comparison each scenario against all other scenarios, correcting for multiple comparisons.

(I) scenario	(J) scenario	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Maximum difference						
Human presence	Subsidized predators	227.46667	207.74874	1.000	-324.2144	779.1477
	Disease	5950.08810	197.60847	<.001	5425.3347	6474.8415
	Habitat Degradation on Land In-holdings	6311.88333	207.74874	<.001	5760.2023	6863.5644
Subsidized predators	Human presence	-227.46667	207.74874	1.000	-779.1477	324.2144
	Disease	5722.62143	231.16146	<.001	5447.3903	6336.4754
	Habitat Degradation on Land In-holdings	6084.41667	239.88758	<.001	5108.7674	6721.4431
Disease	Human presence	-5950.08810	197.60847	<.001	-6474.8415	-5425.3347
	Subsidized predators	-5722.62143	231.16146	<.001	-6336.4754	-5108.7674
	Habitat Degradation on Land In-holdings	361.79524	231.16146	0.712	-252.0588	975.6492
Habitat Degradation	Human presence	-6311.88333	207.74874	<.001	-6863.5644	-5760.2023

(I) scenario	(J) scenario	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
on Land In-holdings	Subsidized predators	-6084.41667	239.88758	<.001	-6721.4431	-5447.3903
	Disease	-361.79524	231.16146	0.712	-975.6492	252.0588
Median difference						
Human presence	Subsidized predators	703.08333	211.75678	0.006	140.7588	1265.4078
	Disease	5204.44524	201.42088	<.001	4669.5680	5739.3225
	Habitat Degradation on Land In-holdings	6301.11667	211.75678	<.001	5738.7922	6863.4412
Subsidized predators	Human presence	-703.08333	211.75678	0.006	-1265.4078	-140.7588
	Disease	4501.36190	235.62120	<.001	3875.6650	6247.3497
	Habitat Degradation on Land In-holdings	5598.03333	244.51567	<.001	4948.7169	5127.0588
Disease	Human presence	-5204.44524	201.42088	<.001	-5739.3225	-4669.5680
	Subsidized predators	-4501.36190	235.62120	<.001	-5127.0588	-3875.6650
	Habitat Degradation on Land In-holdings	1096.67143	235.62120	<.001	470.9745	1722.3684
Habitat Degradation on Land In-holdings	Human presence	-6301.116667	211.75678	<.001	-6863.4412	-5738.7922
	Subsidized predators	-5598.03333	244.51567	<.001	-6247.3497	-4948.7169
	Disease	-1096.67143	235.62120	<.001	-1722.3684	-470.9745

3.1.1 Summary

HexSim modeling of the four threats (human presence, subsidized predators, disease, and habitat degradation on land in-holdings) showed significant differences in their effects on the baseline population model. The ranking of the importance of these threats in causing population decline is as follows:

1. Human presence
2. Subsidized predators
3. Disease
4. Habitat degradation on land in-holdings

Our modeling indicated that threats with a widespread distribution, in particular human presence, were much more important in limiting population growth than those that were patchily-distributed over a

limited area, such as disease, subsidized predators, and degradation of habitat on land in-holdings. Our results suggest that habitat degradation over a broad area could be more important contributors to desert tortoise population decline than patchily distributed threats that cause mortality alone. Also, subsidized predators, which we modeled as a constant threat, was more important in limiting population growth than disease, which we modeled cyclically.

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